ISSN-0039-2502

Journal of the Association of Lunar & Planetary Observers

The Strolling Astronomer

Volume 60, Number 4, Autumn 2018

Now in Portable Document Format (PDF) for
Macintosh and PC-compatible computers
Online and in COLOR at http://www.alpo-astronomy.org

Founded in 1947

Journal of the Association of Lunar & Planetary Observers
The Strolling Astronomer

Volume 60, No.4, Autumn 2018
This issue published in September 2018 for distribution in both portable document format (pdf) and hardcopy format.

This publication is the official journal of the Association of Lunar & Planetary Observers (ALPO).

The purpose of this journal is to share observation reports, opinions, and other news from ALPO members with other members and the professional astronomical community.

For membership or general information about the ALPO, contact:

Matthew Will
ALPO Membership Secretary/Treasurer
P.O. Box 13456
Springfield, Illinois 62791-3456

E-mail to: matt.will@alpo-astronomy.org

Visit the ALPO online at:
http://www.alpo-astronomy.org

Founded in 1947

Inside the ALPO

Papers & Presentations

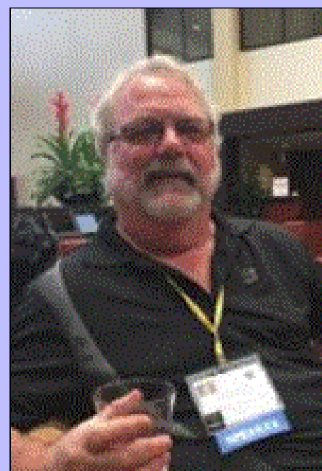
ALPO Resources

Inside the ALPO
Member, section and activity news

Point of View

First and Foremost: 'Observers'

By Tim Robertson, ALPO Training Program & Podcast coordinator



First off, I want to say that I was very humbled and honored to have received the Peggy Haas Service award at this years ALPO conference. To be listed with so many others that I have admired over the years is truly an honor.

I have been a member of the ALPO since the early 1970's. When I think of the ALPO, I think of it as the Association of Lunar and Planetary OBSERVERS. It's that last word that I like to emphasize. We all joined the organization because we loved looking through our telescopes.

The ALPO training program is based upon learning to make visual observations. A trend that I am seeing in the students in the program is a lack of patience to put in the work needed to hone their observing skills. It takes time to learn to observe and we all know that your skills as an observer get better the more you actually have your eye to the eyepiece.

While I was attending this year's conference, I heard a number of amateur astronomers remark that they don't remember the last time they looked through their telescope. At a recent star party, over half the telescopes had laptops hooked up to them showing the "live" image. That doesn't excite me. Maybe I am just getting old and long for the good old days when you could look through all of the telescopes and compare eyepieces, optics, filters, etc. That, to me, is observing.

Don't get me wrong, I love seeing the amazing images of the planets and the Moon that are being made with today's CCD imagers.

But I have a challenge for you the next time you set up to do some imaging. Before you hook up your camera and laptop, take a few minutes and put in an eyepiece and let the photons hit your eye. It just might bring back that feeling you had the first time you ever looked through a telescope.

Inside the ALPO
Member, section and activity news

News of General Interest

Our Cover: Our Friend John Westfall

Please see John's obituary beginning on page 19.

ALPO Board and Staff Updates

We are pleased to announce the following:

- ALPO Comets Section Coordinator Carl Hergenrother has been elected to the association's board of directors by a unanimous vote of the other board members. This follows the very sad passing of our dear friend, John Westfall, who passed away on July 26, 2018.

  Carl was promoted to head the Comets Section several years ago and has proven to be enthusiastic, knowledgeable and effective in his field of cometary studies. His Comets Section reports in each issue of this Journal are informative and detailed enough to draw in even the most basic observer to this worthwhile facet of solar system objects.

- At the suggestion of board member Mike Reynolds, Keith Spring of Orange Park, Florida, has been appointed to the positions of acting assistant coordinator for both the Eclipse Section and the Mercury/Venus Transit Section by ALPO Executive Director Richard Schmude.

  Keith is currently a student at Florida State College at Jacksonville is working towards his bachelor's degree and then a doctorate in Astrophysics. His main interest is stellar systems, specifically exoplanet research, and one day he wishes to work for NASA, cataloging habitable worlds.

  Keith learned about the ALPO through Dr. Mike Reynolds, with whom he has worked for a number of years. In his spare time, Keith enjoys creating solar system simulations to better understand orbital dynamics, as well as practicing astrophotography on any clear night he can find.

Contact information for both Carl and Keith can be found in the *ALPO Resources* section of this Journal.

Keith Spring, acting assistant coordinator for both the ALPO Eclipse Section and the ALPO Mercury/Venus Transit Section. *Photo Source: Keith Spring*.

Carl Hergenrother, ALPO board member and comets section coordinator.

Inside the ALPO
Member, section and activity news

ALPO Interest Section Reports

ALPO Online Section

Larry Owens, section coordinator
Larry.Owens@alpo-astronomy.org

The ALPO web site is now up and fully operational following a major service upgrade by our by our internet service provider.

The ALPO Publications Section portion of the web site is now partially uploaded with only JALP issues previous to 2001 yet left to be uploaded.

Follow us on Twitter, "friend" us on FaceBook or join us on MySpace.

To all section coordinators: If you need an ID for your section's blog, contact Larry Owens at larry.owens@alpo-astronomy.org

For details on all of the above, visit the ALPO home page online at www.alpo-astronomy.org

Computing Section

Larry Owens, section coordinator
Larry.Owens@alpo-astronomy.org

Important links:

- To subscribe to the ALPOCS yahoo e-mail list, http://groups.yahoo.com/group/alpocs/
- To post messages (either on the site or via your e-mail program), alpocs@yahoogroups.com
- To unsubscribe to the ALPOCS yahoo e-mail list, alpocs-unsubscribe@yahoogroups.com
- Visit the ALPO Computing Section online at www.alpo-astronomy.org/computing

Lunar & Planetary Training Program & Podcasts

Tim Robertson, program coordinator
cometman@cometman.net

ALPO Lunar & Planetary Training Program

No current report for this issue.

The ALPO Lunar & Planetary Training Program is open to all members of the ALPO, beginner as well as the expert observer. The goal is to help make members proficient observers. The ALPO revolves around the submission of astronomical observations of members for the purposes of scientific research. Therefore, it is the responsibility of our organization to guide prospective contributors toward a productive and meaningful scientific observation.

'Observers Notebook' Podcasts

ALPO podcasts continue to be released and made available to all.

If you have a subject matter that you would like to hear on the podcast, please drop me a note. I would like to have a discussion on the use of color filters for planetary observing and the timings of Galilean satellite eclipses. If any of you would be interested in discussing those subjects, please let me know.

As stated in my previous report, I am also looking to do member profile pieces where we get to know the members of the ALPO.

A new podcast is released about every two weeks, and if you subscribe via iTunes it will automatically be downloaded to your device.

You can hear the podcast on iTunes, Stitcher, iHeart Radio, Amazon Echo, and Goggle Play just search for Observers Notebook, you can listen to it at the link below:

https://soundcloud.com/observersnotebook

The Observers Notebook is also on FaceBook. Just search for "Observers Notebook" in the search field near the top of your screen.

You can support the podcast by giving as little as $1 a month: for $5, you receive early access to the podcast before it goes public; for a monthly donation of $10, you receive a copy of the Novice Observers Handbook; and for $35 a month, you receive producer credits on the podcast and a year's membership to the ALPO.

You can help us out by going to the link below:

https://www.patreon.com/ObserversNotebook

For more information about the ALPO Lunar & Planetary Training Program or "The Observers Notebook" podcasts, contact Tim Robertson at: cometman@cometman.net, or Tim Robertson, 195 Tierra Rejada Rd #148,

Inside the ALPO
Member, section and activity news

Simi Valley CA, 93065, or go to: www.cometman.net/alpo/

ALPO Observing Section Reports

Eclipse Section

Mike Reynolds, section coordinator
m.d.reynolds@fscj.edu

August 21, 2017 Total Solar Eclipse

You will find in this JALPO issue a report on last year's *Great American Total Solar Eclipse*. We received right at 80 reports! Due to the length of the reports, the eclipse overview (much like a planetary apparition report) provides summaries. We will be adding full reports to the ALPO website in the very near future. My thanks to Theo Ramakers for his invaluable assistance in uploading reports and images to the ALPO website.

July 27, 2018 Total Lunar Eclipse

The ALPO Eclipse Section requests observations of last July's total lunar eclipse if you were positioned to make observations.

January 21, 2019 Total Lunar Eclipse

The first total lunar eclipse of 2019 will be visible from the central Pacific, the Americas, Europe and Africa. In fact, the Americas are best-placed for totality, with all of the continental United States positioned to see the entire eclipse.

Totality will last 62 minutes. The path of the Moon into Earth's shadow is not very central, as can be seen by the diagram.

The ALPO Eclipse Section requests observations of every phase of the eclipse, including contact and crater timings, Danjon Luminosity Estimates, Totality Magnitude Estimates, Sky Brightness, and drawings and photographs.

Visit the ALPO Eclipse Section online at www.alpo-astronomy.org/eclipseblog

Mercury / Venus Transit Section

Visit the ALPO Mercury/Venus Transit Section online at www.alpo-astronomy.org/transit

Inside the ALPO
Member, section and activity news

Meteors Section

Robert Lunsford,
section coordinator
lunro.imo.usa@cox.net

The first half of 2018 was slow for meteor activity. I received very few reports of the Lyrid meteor shower, and the eta Aquariids were badly affected by the Third Quarter Moon this year. The second half of the year is a bit more promising - even though the Orionids and the Ursids are also spoiled by moonlight.

The Geminids are certainly the focal point for meteor observers and hopefully weather conditions will allow unimpeded views of this spectacle. Although some of the major showers are spoiled by moonlight, we encourage observers to try and view the many minor displays that are also active during this time.

A reminder here that your section recorder has taken advantage of podcasts to verbally spread the news of upcoming major meteoric events. Tim Robertson does a great job asking interesting questions while I try my best not to bore the listener! Give these podcasts a try at:

https://soundcloud.com/observersnotebook

Be sure to also check out the other interesting podcasts offered by the many sections of ALPO!

Visit the ALPO Meteors Section online at *www.alpo-astronomy.org/meteorblog/* Be sure to click on the link to viewing meteors, meteor shower calendar and references.

Meteorites Section

Report by Dolores H. Hill,
section coordinator
dhill@lpl.arizona.edu

This report includes information about ALPO member contributions, meteorite highlights and new meteorite approvals from May 1, 2018 to July 30, 2018, from the Meteoritical Society's Nomenclature Committee.

Randy Tatum continues to explore known and possible new terrestrial impact sites in the eastern U.S. He has been studying thin sections of rocks recovered from Middelsboro, KY, and Wells Creek, TN. We continue to receive inquiries about suspected meteorites, most of which are terrestrial and do not require further analysis. ALPO members who collect meteorites are encouraged to report unusual features in their meteorite samples that might be of interest to researchers for specialized analysis.

Meteorite News

The most noteworthy meteorite "fall" during this period was the 2018 LA asteroid that impacted Earth on June 2, 2018. Richard Kowalski of the Lunar and Planetary Laboratory's Catalina Sky Survey at the University of Arizona discovered this small object only 8 hours earlier. While official information on the number of stones recovered and the meteorite's composition is not yet available, social media and popular press report that two stones have been recovered in Botswana. Note that in the entire history of asteroid observing, all three of the (newly) discovered asteroids that collided with Earth to become meteorites were discovered by the same observer. They are 2008 TC3 = meteorite Almahata Sitta, 2014 AA that impacted Atlantic Ocean and 2018 LA (meteorite classification and name to be determined)!

The Meteoritical Bulletin (*https://www.lpi.usra.edu/meteor/*) records officially recognized, classified meteorites of the world's inventory. As of July 26, 2018, it contains a total of 59,218 meteorites (in contrast to 78,3761 known asteroids recorded by the IAU Minor Planet Center (*https://minorplanetcenter.net/mpc/summary*). There were 255 new meteorites

Beautiful green fireball as imaged over Sonora, Mexico, by Sergio Müller the evening of July 7, 2018. © Sergio Müller

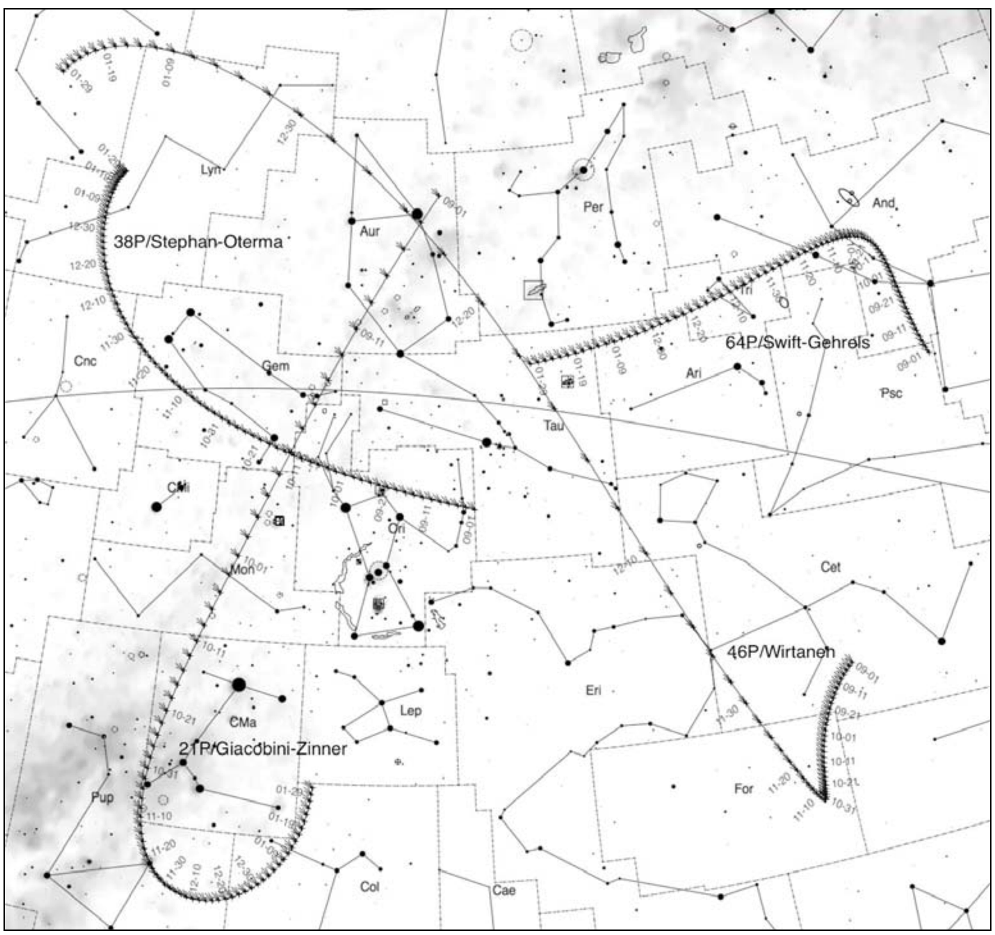
Inside the ALPO
Member, section and activity news

approved, most from desert regions. Newly approved meteorites include 150 ordinary chondrites; 29 carbonaceous chondrites, 5 R chondrites; 13 irons; 7 ureilites; 26 HEDs; 11 lunar; 3 Martian; 3 lodranites; 1 ungrouped achondrite; 2 acapulcoites; 2 brachinites; 3 mesosiderites. For more information and official details on particular meteorites: *https://www.lpi.usra.edu/meteor/metbull.php*

Elephant Moraine 14013 (EET 14013), a CM2 chondrite from Antarctica, was the smallest meteorite reported this period with a mass of only 0.3 grams. The largest meteorite approved was the 120 kilogram IAB-Main Group iron named Nova 027 ("Nova" in meteorite nomenclature designates "unknown find location").

Noteworthy falls approved by the Meteoritical Society's Nomenclature Committee this period include the Ozerki (Russia) L6 chondrite on June 21, 2018. More than 91 pieces were recovered. It exhibits opaque shock veins and impact melt. The San Pedro de Urabá (Colombia) fireball was accompanied by sonic booms in the late afternoon of February 16, 2017. This L6 chondrite fell as two stones. One was recovered at the edge of a soccer field soon thereafter. The Sokoto (Nigeria) IIIAB iron meteorite fell January 10, 2008 and "…destroyed the roof of a house." The meteorite main mass was reportedly broken apart with hammer.

Visit the ALPO Meteorites Section online at *www.alpo-astronomy.org/meteorite/*



Finder chart for comets 21P/Giacobini-Zinner, 38P/Stephan-Oterma, 46P/Wirtanen and 64P/Swift-Gehrels. *Chart provided by the author.*

Comets Section

Report by Carl Hergenrother, section coordinator
carl.hergenrother @ alpo-astronomy.org

The last three months of 2018 promise to be a busy time for comet observers. Four short-period comets will be visible at brighter than 10th magnitude. One of them, 46P/Wirtanen, will peak at 3rd magnitude, making it a naked-eye object in December for observers under dark skies. Two long-period comets will also be visible between magnitudes 10 and 12.

- Discovered in 1900 and re-discovered in 1913, this year marks the 16th observed return for comet 21P/Giacobini-Zinner. 2018 also marks the comet's best apparition since 1959 and best until 2078. Having peaked around magnitude 6.5 to 7.0 in mid-September, Giacobini-Zinner starts October at magnitude 7.6. The comet will fade to 8 in early October, magnitude 9 in late October, magnitude 10 in early November and magnitude 12 in early December as it moves rapidly southward in the morning sky among the stars of Monoceros, Canis Major, Puppis and Columba.
- Halley family comet 38P/Stephan-Oterma is returning for the first time since 1980. Long-time comet watchers may remember observing 38P/Stephan-Oterma back in 1980. This year's return will be similar, though its geocentric distance will be slightly greater. The comet will be brighter than magnitude 11 for the

Inside the ALPO
Member, section and activity news

entire quarter and brighter than magnitude 10 from late October through the end of the year. Perihelion occurs on November 10 at 1.59 AU (147,870,000 miles). Peak brightness at magnitude 9.3 occurs in late November. Stephan-Oterma will resides in the morning sky while moving among the constellations of Orion, Gemini, Cancer and Lynx.

- The brightest comet of the year should be 46P/Wirtanen which will pass within 0.08 AU (7,440,000 miles) of the Earth in mid-December. 46P/Wirtanen will be located around a southerly declination of -30 degrees until late November in the constellations of Cetus and Fornax. During that time, the comet will brighten from 11th to 5th magnitude. By late November, it is rapidly moving northeastward across Eridanus, Aries, Taurus, Perseus, Auriga, Lynx and Ursa Major. Naked eye brightness should be attained by late November. A peak brightness around magnitude 3.1 occurs in mid-December.

Note, that as a short-period comet, 46P/Wirtanen is likely to be a large diffuse object around the time of closest approach. It is possible its coma diameter will be in excess of 1 degree. Do not expect it to appear as bright as a 3rd magnitude star since its light will be spread over a large area. Observers may need a relatively dark sky to see 46P/Wirtanen with the naked eye.

A reminder than 46P/Wirtanen is the focus of an amateur-professional collaboration called the 4*P Coma Morphology Campaign (https://www.psi.edu/41P45P46P). The collaboration is being organized by researchers at the Planetary Science

Ephemerides for Comets 21P/Giacobini-Zinner, 38P/Stephan-Oterma, 46P/Wirtanen, 64P/Swift-Gehrels, C/2016 M1 (PANSTARRS) & C/2016 N6 (PANSTARRS)

Date	R.A.	Decl.	r (au)	d (au)	Elong (deg)	m1	Const	Max El 40°N	Max El 40°S
21P/Giacobini-Zinner									
2018 Oct 01	06 51.51	+00 03.8	1.06	0.45	84	7.6	Mon	43	40
2018 Oct 11	07 08.65	-11 42.1	1.10	0.52	87	8.2	CMa	35	50
2018 Oct 21	07 19.66	-20 41.8	1.17	0.58	91	8.8	CMa	29	59
2018 Oct 31	07 24.97	-27 33.0	1.24	0.65	95	9.5	CMa	22	66
2018 Nov 10	07 24.61	-32 43.1	1.32	0.72	99	10.1	CMa	17	73
2018 Nov 20	07 18.80	-36 25.2	1.40	0.79	103	10.8	Pup	13	81
2018 Nov 30	07 08.35	-38 43.8	1.49	0.85	108	11.4	Pup	11	88
2018 Dec 10	06 54.68	-39 39.9	1.58	0.92	112	12.0	Pup	10	90
2018 Dec 20	06 39.93	-39 15.8	1.68	0.99	116	12.5	Pup	11	89
2018 Dec 30	06 26.32	-37 40.8	1.77	1.07	119	13.1	Col	13	87
38P/Stephan-Oterma									
2018 Oct 01	05 55.93	+11 56.7	1.67	1.20	98	10.8	Ori	60	35
2018 Oct 11	06 20.48	+13 47.8	1.64	1.10	102	10.4	Ori	63	33
2018 Oct 21	06 44.69	+15 54.5	1.61	1.02	106	10.0	Gem	66	31
2018 Oct 31	07 08.14	+18 21.3	1.59	0.94	111	9.7	Gem	68	29
2018 Nov 10	07 30.25	+21 12.2	1.59	0.88	116	9.4	Gem	71	26
2018 Nov 20	07 50.31	+24 29.4	1.59	0.83	122	9.3	Gem	74	23
2018 Nov 30	08 07.56	+28 11.6	1.61	0.79	128	9.3	Gem	78	20
2018 Dec 10	08 21.13	+32 11.7	1.63	0.77	136	9.3	Cnc	82	17
2018 Dec 20	08 30.34	+36 16.1	1.66	0.77	143	9.5	Lyn	86	14
2018 Dec 30	08 34.96	+40 05.0	1.70	0.78	149	9.9	Lyn	90	10
46P/Wirtanen									
2018 Oct 01	01 53.42	-26 14.9	1.42	0.48	144	11.3	For	24	76
2018 Oct 11	01 56.49	-29 09.6	1.34	0.40	141	10.3	For	21	79
2018 Oct 21	01 57.93	-31 35.0	1.27	0.34	137	9.2	For	19	81
2018 Oct 31	01 59.06	-32 59.6	1.20	0.28	132	8.1	For	17	83
2018 Nov 10	02 01.95	-32 43.0	1.15	0.23	128	7.0	For	18	82
2018 Nov 20	02 10.22	-29 37.7	1.10	0.17	126	5.9	For	21	79
2018 Nov 30	02 29.52	-21 11.7	1.07	0.13	129	4.7	Cet	30	70
2018 Dec 10	03 10.51	-00 45.5	1.06	0.09	143	3.5	Cet	52	48
2018 Dec 20	04 33.55	+34 24.9	1.06	0.08	159	3.2	Per	88	12
2018 Dec 30	06 37.80	+55 41.2	1.08	0.11	147	3.9	Lyn	74	0

Inside the ALPO
Member, section and activity news

Ephemerides for Comets 21P/Giacobini-Zinner, 38P/Stephan-Oterma, 46P/Wirtanen, 64P/Swift-Gehrels, C/2016 M1 (PANSTARRS) & C/2016 N6 (PANSTARRS) (Continued)

Date	R.A.	Decl.	r (au)	d (au)	Elong (deg)	m1	Const	Max El 40°N	Max El 40°S
64P/Swift-Gehrels									
2018 Oct 01	00 28.77	+31 27.9	1.45	0.49	151	12.2	And	82	18
2018 Oct 11	00 32.07	+34 10.2	1.42	0.46	151	11.4	And	84	16
2018 Oct 21	00 37.61	+35 59.5	1.40	0.45	150	10.7	And	86	14
2018 Oct 31	00 46.91	+36 51.5	1.39	0.45	149	10.1	And	87	13
2018 Nov 10	01 00.68	+36 48.4	1.40	0.46	147	9.7	And	87	13
2018 Nov 20	01 18.85	+36 00.9	1.41	0.48	144	9.5	And	86	14
2018 Nov 30	01 40.36	+34 43.7	1.43	0.52	142	9.5	Tri	85	15
2018 Dec 10	02 03.86	+33 11.1	1.46	0.57	138	9.6	Tri	83	16
2018 Dec 20	02 28.28	+31 37.0	1.50	0.63	134	9.9	Tri	82	17
2018 Dec 30	02 52.75	+30 10.4	1.55	0.72	130	10.4	Ari	80	18
C/2016 M1 (PANSTARRS)									
2018 Oct 01	14 27.07	-61 51.6	2.29	2.56	62	10.1	Cen	0	36
2018 Oct 11	14 32.27	-63 37.5	2.32	2.67	58	10.3	Cen	0	32
2018 Oct 21	14 39.82	-65 40.9	2.36	2.77	56	10.5	Cir	0	28
2018 Oct 31	14 49.71	-68 01.6	2.40	2.84	54	10.7	Cir	0	27
2018 Nov 10	15 02.30	-70 39.4	2.45	2.90	53	10.8	Aps	0	26
2018 Nov 20	15 18.44	-73 34.0	2.50	2.95	54	11.0	Aps	0	28
2018 Nov 30	15 40.29	-76 44.2	2.55	2.98	55	11.2	Aps	0	31
2018 Dec 10	16 13.56	-80 07.1	2.61	3.00	57	11.4	Aps	0	33
2018 Dec 20	17 16.81	-83 31.6	2.67	3.02	60	11.6	Oct	0	35
2018 Dec 30	19 59.91	-86 02.9	2.73	3.03	63	11.8	Oct	0	38
C/2016 N6 (PANSTARRS)									
2018 Oct 01	09 00.78	+11 49.2	2.78	3.26	53	12.1	Cnc	31	11
2018 Oct 11	09 00.91	+08 55.0	2.81	3.13	62	12.1	Cnc	38	17
2018 Oct 21	08 59.16	+05 51.4	2.85	2.99	72	12.1	Hya	44	23
2018 Oct 31	08 55.14	+02 37.2	2.89	2.85	82	12.0	Hya	48	29
2018 Nov 10	08 48.40	-00 48.1	2.93	2.71	92	12.0	Hya	49	37
2018 Nov 20	08 38.49	-04 22.9	2.97	2.59	102	11.9	Hya	45	45
2018 Nov 30	08 25.10	-08 02.8	3.02	2.48	113	11.9	Hya	42	53
2018 Dec 10	08 08.13	-11 39.1	3.06	2.41	123	11.9	Pup	38	61
2018 Dec 20	07 47.96	-14 59.2	3.12	2.37	132	12.0	Pup	35	65
2018 Dec 30	07 25.59	-17 49.2	3.17	2.38	137	12.1	CMa	32	68

Institute which requests images of the near-nucleus region of the comet. The images will be used to determine the rotational state of the nucleus, characterization of the nucleus' activity, characterization of outbursts, gas and dust properties in the coma (for example, outflow velocities), chemical origin of gas species in the coma, and temporal behavior of the tail structure. The ALPO Comet Section will share appropriate images of 46P/Wirtanen to the 4*P Coma Morphology Campaign with the consent of the observer.

- 64P/Swift-Gehrels was originally discovered visually by Lewis Swift (Rochester, New York) in 1889. After the 1889 apparition, the comet went unobserved until 1973 when its was discovered by Tom Gehrels on photographic plates taken at Palomar Observatory in southern California. 2018 marks 64P/Swift-Gehrels' 7th observed return. Since its discovery in 1889, the comet's orbit has been fairly stable with an orbital period of 9.4 years and perihelion distance near its current value of 1.39 AU (129,270,000 miles). Not an especially bright object, this year's return will be its best known return with a minimum Earth-comet distance of 0.44 AU (40,920,000 miles) on October 28. You will have to wait until 2092 for another return as good as this year's. Based on it brightness at past returns, 64P/Swift-Gehrels should start October at magnitude 12.2 and peak around magnitude 9.5 in late November. The comet will spend the entire quarter in the morning sky among the stars of Andromeda and Triangulum.

Inside the ALPO
Member, section and activity news

Founded in 1947

In addition to the short-period comets, two long-period comets should be brighter than 12th magnitude for some part of this quarter.

- C/2016 M1 (PANSTARRS) has been bright for much of the year with a peak at 8th magnitude in June. With a distant perihelion of 2.21 AU (205,530,000 miles) on August 10, the comet is slowly fading as it recedes into the depths of the outer solar system. This comet is solely a southern hemisphere object now as it fades from magnitude 10.1 to 11.8.
- The other long-period comet, C/ 2016 N6 (PANSTARRS), is visible from both hemispheres as it peaks around magnitude 12. Perihelion occurred back on July 18 at 2.67 AU (248,310,000 miles).

As always, the Comet Section is happy to receive all comet observations, whether images, drawings, magnitude estimates, and even spectra. Please send your observations via email to *carl.hergenrother @ alpo-astronomy.org*

Drawings and images of current and past comets are being archived in the ALPO Comets Section image gallery at *http://www.alpo-astronomy.org/gallery/main.php?g2_itemId=4491*

Visit the ALPO Comets Section online at *www.alpo-astronomy.org/comet*

Solar Section

Report by Rik Hill, section coordinator & science advisor
rhill@lpl.arizona.edu

Though the solar activity continues to decline, the observers of the ALPO Solar Section remain steadfast in their observing with an average of 225 submissions for each rotation in the last quarter. So far this year (as of August 5) we've had 123 days of 0 sunspot count (RI) or about 56% of the year, according to spaceweather.com. This is a milestone, as we have passed the 50% threshold. This is the most such days since 2009.

Membership remains strong and we welcome Tom Mangelsdorf of Alaska to the fold and welcome back Frank Melillo after an extended hiatus while equipment was being repaired and Joe Gianninoto after “breaking in” some new equipment.

Theo Ramakers has been working on upgrades to all the ALPO Gallery pages and they are great! Currently the Solar Section has over 38,000 images and reports in our archive. I hope you will take some time to look it over!

Our email list continues as the main mode of rapid communication among observers. Its smooth operation is due to Rick Gossett's vigilance. It's a good way to share information about solar and section activity as seen by our members around the world.

Pam Shivak continues to keep our presence on Facebook where a lot of our new members come from and where the ALPO has its own page.

Watch at conventions and meetings for the new ALPO Solar Section poster that will soon be distributed to our staff. It was designed to be a 2x3 foot banner that will also print up nicely on 8 ½ x11 sheets.

To join the Yahoo Solar ALPO e-mail list, please go to *https://groups.yahoo.com/neo/groups/Solar-Alpo/info*

For information on solar observing – including the various observing forms and information on completing them – go to *www.alpo-astronomy.org/solar*

Mercury Section

Report by Frank J. Melillo, section coordinator
frankj12@aol.com

By the time you read this, Mercury will have ended its favorable morning apparition and is entering the evening sky once more. Usually, this time of the year as seen from the northern hemisphere, the ecliptic path is very shallow after sunset. Even the planet Venus at its greatest elongation still doesn't stand that high, let alone Mercury, which sets about an hour after sunset.

If you have an urge to see Mercury after sunset, the best time to see it will be on October 28. That evening, Mercury will be at least 3 degrees south of Jupiter. While Jupiter is approaching conjunction with the Sun, the pair will set about one hour after the Sun, so it will be necessary to catch both Mercury and Jupiter in a bright twilight. A pair of binoculars will do a nice job of locating Mercury if you use Jupiter as a guide. Jupiter might be easily visible at -1.8 magnitude, while Mercury will shine at a respectable -0.2 magnitude.

Telescopically, Mercury will appear as a gibbous disk with a diameter of 5.7". Mercury will reach the greatest elongation on November 6. Of course, you will find both planets near to each other from October 25 to November 7.

After inferior conjunction with the Sun on November 27, Mercury will once more enter the morning sky.

This upcoming apparition will be the best of the year — you won't have a problem observing Mercury for the whole month of December! Starting December 5, you will increase your chance of spotting Mercury with a nearby crescent Moon when you use a pair of binoculars. It will shine an average magnitude of +0.7. As we head to December 15, Mercury will

Inside the ALPO
Member, section and activity news

reach the greatest elongation at 21 degrees west of the Sun. It will shine brighter than normal, at -0.4 magnitude. Through an eyepiece, it will appear as a slightly gibbous phase with a disk diameter of 6.7 arc-seconds. Mercury will remain pretty bright for the remainder of the month. Also, Venus will join this tiny planet, so both of them will have a nice naked-eye view before sunrise.

Additionally, Jupiter will join Mercury on December 21 at about just a little less than a degree apart.

Please send in your observations to the Mercury section so we can have nice coverage of its favorable morning apparition of the year.

Visit the ALPO Mercury Section online at *www.alpo-astronomy.org/mercury*

Venus Section

Report by Julius Benton, section coordinator
jlbaina@msn.com

Venus is relatively low in the western evening sky this fall, having reached greatest elongation east during the summer back on August 17. During the current 2018 Eastern (Evening) Apparition, Venus is passing through its waning phases (a progression from a nearly fully illuminated disk through crescent phases). So observers are witnessing the leading hemisphere of the planet as it increases its apparent diameter at the time of sunset on Earth.

Venus was at greatest brilliancy on September 22, at visual magnitude -4.7, and will enter into inferior conjunction with the Sun on October 27, ending the eastern (evening apparition.

The accompanying table of Geocentric Phenomena in Universal Time (UT) is presented for the convenience of observers for the 2018 Eastern (Evening) Apparition

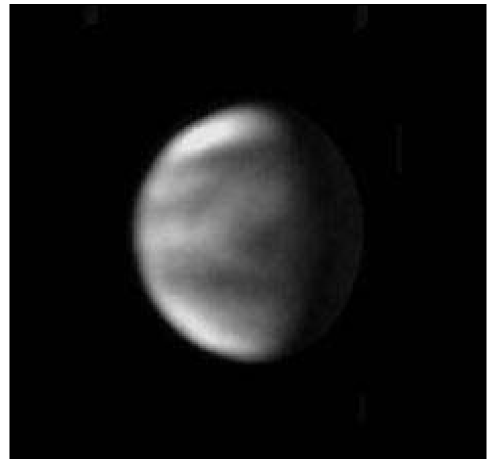
As of mid-summer, ALPO Venus Section observers have submitted over 100 digital images of the planet taken in integrated light, color filters, and at UV and IR wavelengths as well as visual drawings for the 2018 eastern (evening) apparition.

Readers of this Journal should be well-acquainted with our on-going collaboration with professional astronomers as exemplified by our sharing of visual observations and digital images at various wavelengths during ESA's previous Venus Express (VEX) mission that ran from 2006 and ended in 2015. It remains as one of the most successful Pro-Am efforts involving ALPO Venus observers around the globe. These observations shall remain important for further study and will continue to be studied and analyzed for several years to come as a result of this endeavor. For reference, the VEX website is

http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=38833&fbodylongid=1856.

Geocentric Phenomena of the 2018 Eastern (Evening) Apparition of Venus in Universal Time (UT)

Superior Conjunction	2018 Jan 09^d 10^h (angular diameter = 9.7″)
Greatest Illuminated Extent	Sep 22 00 UT (m_v = –4.7)
Predicted Dichotomy	Aug15.22 ^{d} (Venus is predicted to be exactly half-phase)
Greatest Elongation East	Aug 17 00 (46°)
Inferior Conjunction	2018 Oct 27 11 (angular diameter = 61.8″)



Rik Hill of Tucson, AZ submitted this excellent UV image taken at 02:22 UT on June 20, 2018 employing his 20.3 cm (8.0 in.) MAK (Maksutov Cassegrain) in very good seeing conditions (S = 8.0). This image clearly shows a shaded and somewhat irregular terminator with the characteristic horizontal V, Y, or ψ (psi) shaped dusky clouds that are typically aligned along the planet's equatorial region and terminator at UV wavelengths. The north and south cusp caps are visible. The apparent diameter of Venus is 14.8", gibbous phase (k) 0.739 (73.9% illuminated), and visual magnitude -3.9. South is at top of image.

A follow-up Pro-Am effort is underway with Japan's (JAXA) *Akatsuki* mission that began full-scale observations a year ago beginning in April 2016, and although the mission is continuing well into 2018, and the website for *Akatsuki* mission has already "gone live" so that interested and adequately equipped ALPO observers can still register and start submitting images if they have not already done so. More information will continue to be provided on the progress of the mission in forthcoming reports in this Journal.

It is extremely important that all observers participating in the programs of the ALPO Venus Section always first send their observations to the ALPO Venus Section at the same

Inside the ALPO
Member, section and activity news

Lunar Calendar for October through December 2018

2018	Universal Time	Event
Oct 02	05:45	Last Quarter
02	09:03	Moon Extreme North Dec.: 21° N
03	23:10	Moon Ascending Node
05	18:29	Moon Perigee: 366400 km
08	23:47	New Moon
11	17:21	Moon-Jupiter: 4.3° S
14	23:01	Moon-Saturn: 2° S
15	13:26	Moon Extreme South Dec.: 21.2° S
16	14:02	First Quarter
17	08:03	Moon Descending Node
17	15:16	Moon Apogee: 404200 km
18	09:01	Moon-Mars: 2.2° S
24	12:45	Full Moon
29	13:34	Moon North Dec.: 21.3° N
30	22:46	Moon Ascending Node
31	11:40	Last Quarter
31	15:05	Moon Perigee: 370200 km
Nov 07	11:02	New Moon
11	10:46	Moon-Saturn: 1.6° S
11	21:21	Moon Extreme South Dec.: 21.4° S
13	09:04	Moon Descending Node
14	10:57	Moon Apogee: 404300 km
15	09:54	First Quarter
15	23:16	Moon-Mars: 1.1° N
23	00:39	Full Moon
25	20:48	Moon North Dec.: 21.5° N
26	07:10	Moon Perigee: 366600 km
27	00:18	Moon Ascending Node
29	19:19	Last Quarter
Dec 03	13:42	Moon-Venus: 3.8° S
07	02:20	New Moon
09	00:30	Moon-Saturn: 1.2° S
09	06:12	Moon Extreme South Dec.: 21.5° S
10	12:57	Moon Descending Node
12	07:25	Moon Apogee: 405200 km
14	18:21	Moon-Mars: 3.9° N
15	06:49	First Quarter
22	12:49	Full Moon
23	06:48	Moon Extreme North Dec.: 21.6° N
24	04:52	Moon Perigee: 361100 km
24	06:54	Moon Ascending Node
29	04:34	Last Quarter

Table courtesy of William Dembowski and NASA's SkyCalc Sky Events Calendar

time submittals are contributed to the *Akatsuki* mission.

This will enable full coordination and collaboration between the ALPO Venus Section and the *Akatsuki* team in collection and analysis of all observations whether they are submitted to the *Akatsuki* team or not. If there are any questions, please do not hesitate to contact the ALPO Venus Section for guidance and assistance.

Those still wishing to register to participate in the coordinated observing effort between the ALPO and Japan's (JAXA) *Akatsuki* mission should utilize the following link:

https://akatsuki.matsue-ct.jp/

The observation programs of the ALPO Venus Section are listed on the Venus page of the ALPO website at http://www.alpo-astronomy.org/venus as well as in considerable detail in the author's *ALPO Venus Handbook* available from the ALPO Venus Section as a pdf file.

Observers are urged to attempt to make simultaneous observations by performing digital imaging of Venus at the same time and date that others are imaging or making visual drawings of the planet. Regular imaging of Venus in both UV, IR and other wavelengths is important, as are visual numerical relative intensity estimates and reports of features seen or suspected in the atmosphere of the planet (for example, dusky atmospheric markings, visibility of cusp caps and cusp bands, measurement of cusp extensions, monitoring the Schröter phase effect near the date of predicted dichotomy, and looking for terminator irregularities).

Routine use of the standard ALPO Venus observing form will help observers know what should be reported in addition to supporting information such as telescope aperture and type, UT date and time, magnifications and filters used, seeing and transparency conditions, etc. The

Inside the ALPO
Member, section and activity news

ALPO Venus observing form is located online at:

http://www.alpo-astronomy.org/gallery/main.php?g2_view=core.DownloadItem&g2_itemId=85642

Venus observers should monitor the dark side of Venus visually for the Ashen Light and use digital imagers to capture any illumination that may be present on the plane as a cooperative simultaneous observing endeavor with visual observers. Also, observers should undertake imaging of the planet at near-IR wavelengths (for example, 1,000 nm), whereby the hot surface of the planet becomes apparent and occasionally mottling shows up in such images attributable to cooler dark higher-elevation terrain and warmer bright lower surface areas in the near-IR.

The ALPO Venus Section encourages readers worldwide to join us in our projects and challenges ahead.

Individuals interested in participating in the programs of the ALPO Venus Section are encouraged to visit the ALPO Venus Section online *http://www.alpo-astronomy.org/venusblog/*

Lunar Section

Lunar Topographical Studies / Selected Areas Program

Report by Wayne Bailey, program coordinator
wayne.bailey@alpo-astronomy.org

The ALPO Lunar Topographical Studies Section (ALPO LTSS) received a total of 150 observations from 15 observers during the April-June quarter.

Thirteen contributed articles were published in addition to numerous commentaries on images submitted.

Bill Dembowski continued the series of articles on lunar rays and the *Focus-On* series continued under Jerry Hubbell, with an article on Craters. The next *Focus-On* subjects will be a series on each of the Apollo landing sites.

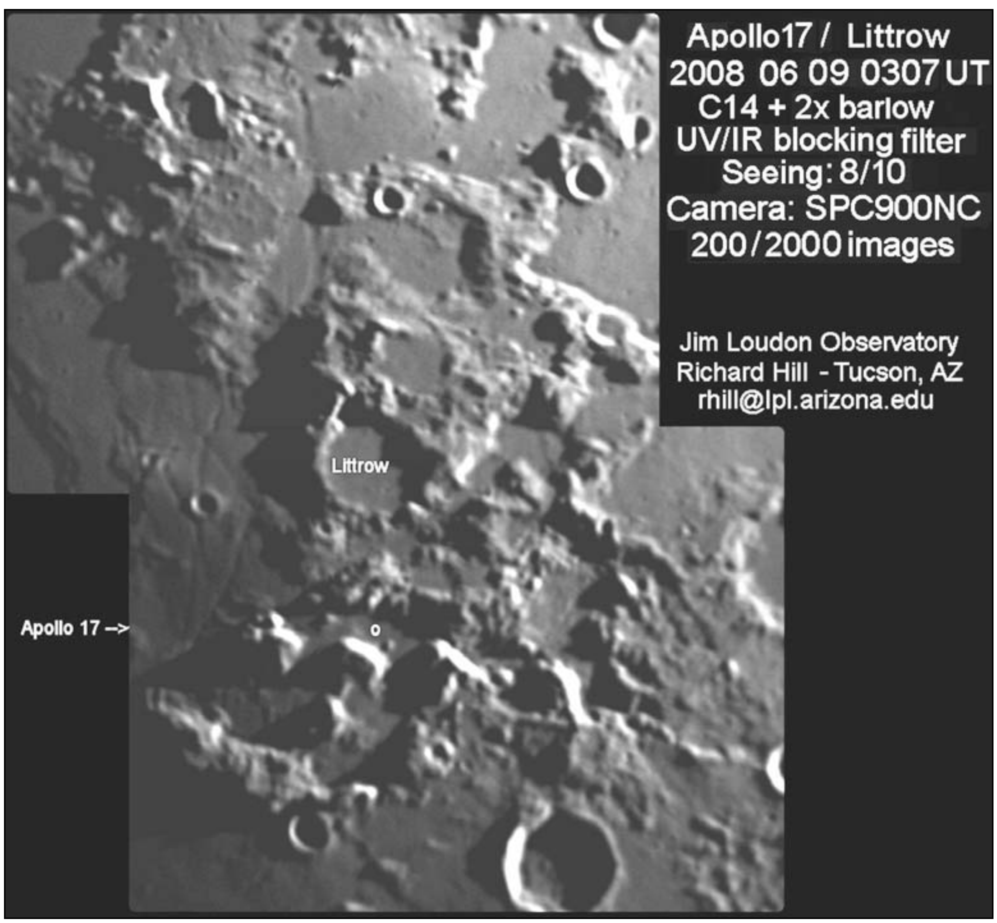
Electronic submissions can now be submitted through the ALPO website (lunar@alpo-astronomy.org). (The former method of sending them to both myself and Jerry Hubbell will still work, but please don't submit both through the website and directly). See the most recent issue of The Lunar Observer (moon.scopesandscapes.com/tlo) for instructions on its use. Hard copy submissions should continue to be mailed to me at the address listed in the ALPO resources section of the Journal.

The lunar image gallery/archive is also now active, although at this writing, it is very sparsely populated. Images will be inserted beginning with the recent ones and working backwards. Thanks to Theo Ramakers and Larry Owens for setting up the gallery.

Visit the following online web site for more info moon.scopesandscapes.com (including current and archived issues of *The Lunar Observer*).

Lunar Meteoritic Impacts

Brian Cudnik, program coordinator
cudnik@sbcglobal.net



(Source: September 2018 *The Lunar Observer*.)

Inside the ALPO
Member, section and activity news

This coordinator received a report in late July from Tiago Augusto in Brazil on some likely lunar meteor impacts, two of which happened about the same time. An impact flash occurred at 23:01:36 UT on July 17. This event was observed as part of a lunar program in operation for two years and was made at one observatory operated by the Remote Observatory of Campos dos Goytazes (ROCG) and the Exoss Lunar Team. Other observers on this team include Carlos Henrrique Barreto (who recorded what may be the same flash on 7/17/2018 at 23:01:26 UT. We are as of yet unsure why this one has exactly 10 seconds difference in time from the other) and Torres Moreira.

In addition to the July 17 impact(s), the team reports a flurry of impact flashes in May. The team "witnessed lots of suspicious flashes between 05/22/2018 & 05/23/2018." We are awaiting verification of an outburst of meteoroids on the Moon during this time frame. The eta Aquariids is past peak and only minor showers are active at this time.

The web site of the Exoss Lunar Program along with images and data on impact flashes can be found here:

http://press.exoss.org/projetos-2/impacto-lunar/registros-de-impacto-lunar-no-brasil/

A news report about the July 17 impacts posted on the LinkedIn networking website (and also found on space.com) stated that the meteor impacts that hit the Moon on July 17 were estimated to be about the size of walnuts and determined to be members of a minor meteor stream alpha Capricornids. This minor stream is derived from the comet 169P/NEAT. Confirming observations for the above flashes are requested; also, if anyone has observed a flash that needs verification, please let us know.

We had at least a fair shot at capturing lunar Perseids this month. The Moon was New just before the maximum but the waning crescent Moon leading up to New, as well as, and especially the waxing crescent Moon after the 13th were favorably placed for observation of lunar Perseids. The section will continue the ongoing work of coordinating observations for this and other meteor showers throughout the remainder of 2018 and beyond. Check the ALPO website and/or join the "Lunarimpacts" listserve for more information.

Please visit the ALPO Lunar Meteoritic Impact Search site online at *http://alpo-astronomy.org/lunarupload/lunimpacts.htm*

Lunar Transient Phenomena

Report by Dr. Anthony Cook, program coordinator
tony.cook@alpo-astronomy.org

Of the many observations made during our repeat illumination observing schedules (*http://users.aber.ac.uk/atc/lunar_schedule.htm*), one especially interesting report has come to our attention:

- Cichus-Weiss area: 2018 Feb 24 UT 21:35 Mick Crook (UK) observed a needle, or thread-like, light area beyond the terminator. This is normal, as it is formed by the first vestiges of sunrise coming through a gap in the highlands to the east. However, Mick noted initially a silver cast to this sunlight, but later a golden hue. The ALPO/BAA weight assigned to this report was 2. We would welcome attempts at color imaging during the formation of this needle-like Sun-ray at dates and times given on the above web site in order to see if we can replicate this effect.
- On 2018 Jun 20 UT 02:46, Rik Hill (Tucson, AZ USA) imaged the Julius Caesar region in a mosaic, and part of this just clipped the Ross D area, which was under both repeat illumination and topocentric libration, to within ±1° to an LTP report by Daniel Harris, concerning the crater Ross D from 1964 May 18 UT 03:54-04:53. You can compare Rik's modern day image, to the original sketch on page 18 of the August *The Lunar Observer* newsletter of the ALPO Lunar Section. For comparison, it would be really very helpful to have additional high resolution images of this area at dates and times given on the web site: *http://users.aber.ac.uk/atc/tlp/tlp.htm* .

We welcome new participants in our program, whether they are experienced visual observers, or high-resolution lunar imagers. This helps us to solve some past historical lunar observational puzzles.

A list of dates and UTs to observe repeat illumination events can be found on: *http://users.aber.ac.uk/atc/lunar_schedule.htm*, and LTP observational alerts are given on this Twitter page: *https://twitter.com/lunarnaut*

Finally, please visit the ALPO Lunar Transient Phenomena site online at *http://users.aber.ac.uk/atc/alpo/ltp.htm*

Lunar Domes

Report by Raffaello Lena, acting program coordinator
raffaello.lena@alpo-astronomy.org

We have received many images including some by Richard Hill, Carmelo Zannelli, Raffaele Barzacchi, Tom Astron, K.C. Pau, George Tarsoudis, Rafael Benavides, Merce Marimon and Ryan Cornell for a total of 27 images. Some images display the well-known Milichius

Inside the ALPO
Member, section and activity news

and Cauchy domes. Many images are shared in our Facebook group Lunar Dome Atlas Project (*https://www.facebook.com/groups/814815478531774/*).

At the present, we are working on a report regarding the Tobias Mayer-Milichius domes field where another low dome was identified analyzing hi-res images made by Zannelli, Barzacchi and Phillips. The identification of further domes and lunar cones in the wide Marius shield is ongoing and future updates will be done, including morphometric and spectral properties.

Richard Hill has reported a dome in the Kies region. It (termed K3) lies at coordinates 13.78° N and 29.24° W and has a base diameter of 20 km. This dome was previously discovered by Phillips on December 29, 1983 with a drawing made using a 6-inch refractor, but no measurements were made at the time. The dome height is now determined to 130±15 m, while the average slope angle corresponds to 0.72°±0.1° (Fig. 1).

Hill has reported another suspect feature near the craters Plana and Mason. The suspected bump lies at 41.05°N and 29.7°E and could be an isolated dome. Based on a preliminary analysis, it is about 80 m high, though we recommend more hi-res images of the region under strongly oblique solar illumination angle for maximum detail.

Carmelo Zannelli and Rafael Benavides have imaged the dome Kepler1 (Ke1) and the dome Encke1, which was described in a previous article published in spring issue of this Journal (JALPO 60-2). The dome Ke1 (Fig. 2) is 170±15 m high and the diameter amounts to 13.9±0.3 km, yielding an average slope angle of 1.4°±0.1°. During a survey organized with some observers of the BAA, I have examined the western branch of the Apennine Bench Formation (ABF) which occurs south of Archimedes. Deposits of this crater have altered the primary surface textures of the region. Interestingly, the western part of the bench is elevated relative to the adjacent mare by an average of about 500 m, whereas the mare surfaces average to 100-200 m. The elevation of the structure is very apparent (Fig. 3).

To the east is detectable another lunar dome, which is termed Huxley 1 (Hux1) with a diameter of 14 km, as reported in another our previous work. Based on the boundaries of this complex structure, it can be considered a possible megadome, extending for 120 km and with an average slope angle of 0.5°. Interested observers can participate to the lunar domes program by contacting and sending their observations to both Raffaello Lena (coordinator email *raffaello.lena@alpo-astronomy.org*) and Jim Phillips (assistant coordinator (*thefamily90@gmail.com*).

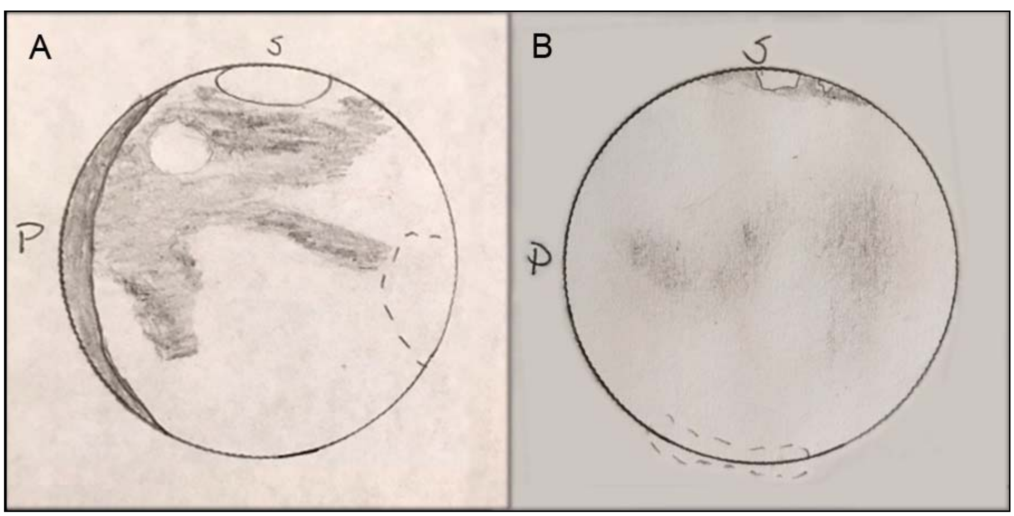


Figure 1. Two drawings of Mars by Robert Bunge, of Maryland, USA.
A. Made June 4, 2018, at 08:50 UT, with CM = 310°. The dark Syrtis Major and Sabaeus Sinus and the bright Hellas and SPC were clearly seen, while Noachis appeared unusually dark. The dust was spreading from the west (right side), obscuring Mare Erythraeum and Mare Acidalium and appearing bright over Oxia, Chryse, and Margaritifer Sinus which normally would have been seen there. Newtonian telescope of 6-inch aperture, at 234x magnification. Filters not specified. Seeing = 9.
B. Made July 15, 2018, at 06:10 UT, with CM = 265°. Note that the SPC is largely obscured and dark, while the NPH at the bottom is light. The tallest of the vague dark features, on the right side of the disc, is Syrtis Major and Iapygia. The two dark features to its left represent Syrtis Minor and Tritonis Sinus. The hiding of detail by the dust is striking. Newtonian telescope of 20-inch aperture at magnification of 234x, 480x and 1,100x, through a W25A red filter. Seeing = 9.

Inside the ALPO
Member, section and activity news

Mars Section

Report by Roger Venable, section coordinator
rjvmd@hughes.net

While Mars became spectacularly bright in the morning sky in the last few months, a global dust storm enveloped it so that the view of its albedo features was obscured. This is frustrating for those who wish to see the features of Mars, but it was interesting to witness the progression of the storm.

This storm was very unusual in that it was the first observed global storm to begin in the Northern Hemisphere and also the earliest such storm in the Martian Spring. Many persistent observers documented the spread and deepening of the obscuration, and then its clearing.

Several naked eye observers noticed that Mars was more yellow than usual during the storm, as compared to its ruddy dust-free appearance. Robert Bunge drew the planet when the storm was in its early phase (Figure 1, panel A) and again during its complete phase (Figure 1, panel B). Peter Gorczynski imaged the planet during the storm's global phase and demonstrated that infrared penetrates through the dust to the surface better than red does, while green penetrates less and blue penetrates none (Figure 2). Hundreds of other observations have also been received.

We expect there to be much clearing of the view to the surface by the time you read this, and this apparition still promises to afford the best views of the planet's surface since 2003.

Please send your reports directly to me at rjvmd@hughes.net, or post them into the photos section of the Yahoo Mars observers group at *https://groups.yahoo.com/neo/groups/marsobservers*

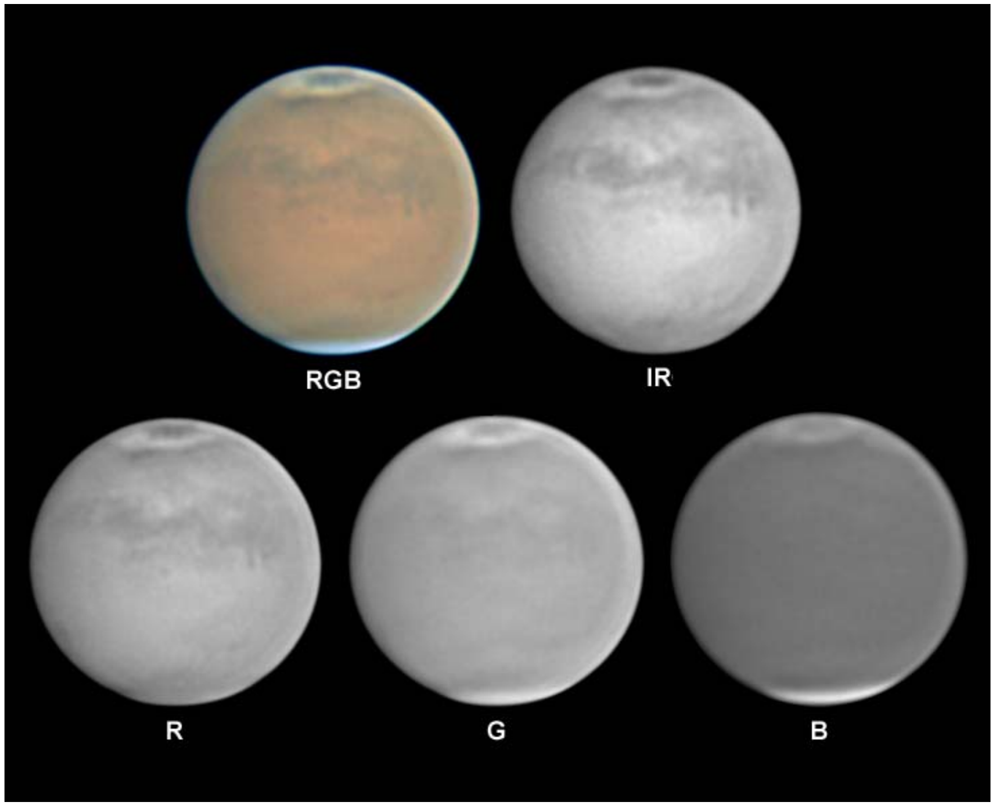


Figure 2. RGB and IR images by Peter Gorczynski of Connecticut, USA, made July 21, 2018, from 04:29 to 04:44 UT. CM is 188 to 192. Partial clearing of the dust is evident. Note that the surface detail can be seen best in IR, next best in red, with only a hint at surface detail in green and none in blue light. Since water ice clouds reflect blue light but are efficiently penetrated by IR, the NPH at the bottom of the images is bright in blue, and less bright as progressively longer wavelengths are used. The SPC has a dense dust core in its center. Maksutov telescope of 180 mm aperture, Astronomik R, G, and B filters and a Baader IR filter.

Minor Planets Section

Frederick Pilcher, section coordinator
pilcher35@gmail.com

Some of the highlights published in the *Minor Planet Bulletin*, Volume 45, No. 4, October-December 2018, are hereby presented. These highlights represent the recent achievements of the ALPO Minor Planets Section.

A satellite of an asteroid may be detected photometrically if a brief dip is observed in the rotational lightcurve as the secondary either transits or is occulted by the primary. Their combined light is reduced during these satellite events. Dual-period software can separate the two lightcurves with separate periods from the observed combined lightcurve. Several asteroids with this behavior were reported, as in the accompanying table.

If the satellite's orbital plane is not close to the line of sight, satellite events are not observed. It may be possible to detect the presence of the satellite if primary and secondary have different rotation periods and amplitudes, and their combined lightcurve can be separated with dual

Inside the ALPO
Member, section and activity news

period software. Asteroids reported to have different primary and secondary rotation periods, but no observed transit/occultation events, are also listed in the accompanying table.

Tumbling behavior (simultaneous rotation about a principal axis and precession of that axis) was observed for asteroids also listed in the accompanying table. It was not possible to determine which period was rotation and which was precession

Three other very small Earth approachers were found to have very short rotation periods, faster than the centrifugal limit and therefore indicative of their being solid rocks (monoliths) rather than rubble piles.

In addition to asteroids specifically identified above, lightcurves with derived rotation periods are published for 157 other asteroids as listed below:

33, 49, 91, 132, 235, 289, 323, 418, 424, 461, 504, 617, 719, 791, 820, 821, 832, 866, 874, 896, 910, 965, 1049, 1090, 1097, 1117, 1180, 1184, 1237, 1266, 1315, 1326, 1329, 1334, 1382, 1533, 1555, 1591, 1594, 1627, 1737, 1741, 1748, 1793, 1856, 1866, 1877, 1887, 2021, 2040, 2061, 2164, 2204, 2353, 2449, 2558, 2623, 2656, 2672, 2764, 2811, 2827, 2895, 2956, 3002, 3198, 3210, 3287, 3341, 3343, 3363, 3394, 3483, 3738, 3800, 3995, 4022, 4142, 4221, 4348, 4435, 4488, 4522, 4575, 4713, 4911, 5129, 5133, 5251, 5518, 5579, 5852, 5928, 5996, 5999, 6358, 7529, 8083, 9856, 10113, 11434, 11864, 11889, 12769, 13035, 13538, 14339, 14892, 15318, 15549, 16070, 19911, 20447, 21893, 22283, 25916, 26074, 36183, 36198, 42237, 42273, 42284, 42701, 44283, 60381, 63583, 65996, 68347, 75768, 76978, 85953, 85989, 86401, 26421, 137509, 138847, 139289, 148567, 153957, 162168, 220839, 337084, 387814, 415029, 444193, 450648, 455550, 467309, 469737, 505657, 2015 DP155, 2016 JP, 2017 YE5, 2018 BY2, 2018 EB, 2018 EJ4, 2018 FQ5.

Secure periods have been found for some of these asteroids, and for others only tentative or ambiguous periods. Some are of asteroids with no previous lightcurve photometry, others are of asteroids with previously published periods that may or may not be consistent with the newly determined values. Newly found periods that are consistent with periods previously reported are of more value than the uninitiated may realize. Observations of asteroids at multiple oppositions widely spaced around the sky are necessary to find axes of rotation and highly accurate sidereal periods.

The *Minor Planet Bulletin* is a refereed publication and that it is available online at:

http://www.MinorPlanet.info/MPB/mpb.php

Annual voluntary contributions of $5 or more in support of the publication are welcome.

Please visit the ALPO Minor Planets Section online at http://www.alpo-astronomy.org/minor

Jupiter Section

Report by section staff members Schmude, MacDougal and McAnally

To repeat the intro from this section report from JALPO60-3, Richard Schmude is once more at the helm of this section following the unfortunate choice by Ed Grafton to step down for health reasons. All wish Ed the best. In addition, Richard now also is coordinator of the Galilean Satellites Eclipse Program

Table 1. Asteroids Detailed in This Report

Minor Planet	Type	Author(s)	Primary Rotation Period (h)	Orbital Revolution Period (h	Status
Asteroids with Occulting Satellites					
2207 Antenor	Trojan	R.Stephens et al.	7.9645	uncertain	tentative
2491 Tvashtri	Hungaria	B. Warner	4.0852	26.712	secure
15745 Yuliya Amor type	Amor type	V. Benishek et al.	3.2495	11.735	secure
29168 1990 KJ	Main belt	R. Stephens	2.5827	35.66	tentative
66391 1999 KW4	Near Earth	B. Warner	2.7660	17.452	secure
Asteroids with Non-Occulting Satellites					
85628 1998 KV2	Amor type	B. Warner	2.999	13.28	tentative
139345 2001 KA67	Near Earth	Stephens, Warner	44.25	6.011	tentative
2013 US3	Near Earth	B. Warner	450	2.4050	tentative
Tumbling Asteroids					
1144 Oda	Outer main belt	F. Pilcher	648	553	—
2010 WC9	Near Earth	B. Warner	0.18469	0.12376	—
Probably Solid Rock Asteroid (Very Fast Rotation Periods)					
2018 GE3	Near Earth	A. I. Gornea et al.	0.304		—
2018 JX	Near Earth	B. Warner	0.057637		—
2018 LK	Near Earth	B. Warner	0.123		—

Inside the ALPO
Member, section and activity news

following the decision by John Westfall to also step down.

- The 2014-15 Jupiter apparition report appeared in previous issue of this Journal (JALPO60-3). Work will begin early in 2019 on the 2015-2016 Jupiter apparition report.
- Coordinator Schmude has just finished a second edition of the Jupiter handbook which should be for sale by the Astronomical League in early 2019.
- Jupiter will be approaching conjunction with the Sun in early November. Therefore, you will have only a brief opportunity to observe it in evening twilight in early October.
- He continues to measure the brightness of Jupiter using both visible and near infrared light.
- Craig MacDougal reports that the ALPO Jupiter Yahoo group had 511 members as of July 15, 2018. Members report the South Equatorial Belt following the Great Red Spot remains turbulent. They also report Oval BA has a dark border and the Great Red Spot is getting darker.

Visit the ALPO Jupiter Section online at *http://www.alpo-astronomy.org/jupiter*

Galilean Satellite Eclipse Timing Program

Editor's Note: Former program coordinator John Westfall completed several reports for publication in this Journal. For various reasons, John passed ownership of this program to Richard Schmude.

An Excel catalog of this program's observations from the 1975/76 through the 2000/01 Jupiter apparitions is available. The read-only, two-megabyte file contains the results of 10,308 visual timings, with 20 entries for each timing. The data are more detailed than given in the reports published in this Journal over the years, and include observed UT, delta-t, the predicted event time based on the Lieske E-2 ephemeris, as well as the observer name, instrument aperture, and observing conditions.

Contact Richard Schmude via e-mail at *schmude@gordonstate.edu* to obtain an observer's kit, also available on the Jupiter Section page of the ALPO website.

Saturn Section

Report by Julius Benton, section coordinator
jlbaina@msn.com

Saturn remains reasonably well-placed for worthwhile observation throughout the autumn months. Saturn reached opposition on June 27, becoming visible most of the night.

The accompanying Table of Geocentric Phenomena for the 2018-19 Apparition in Universal Time (UT) is included here for the convenience of observers.

As of this writing, the ALPO Saturn Section has received numerous excellent images of the planet at visual and infrared wavelengths during the current 2018-19 apparition. Observers are reporting discrete atmospheric phenomena in Saturn's northern hemisphere, including what appears to be a recurring white spot in the EZn (northern half of the Equatorial Zone), as well as a small white spot in the EZs (southern half of the Equatorial Zone, as well as a persistent group of white spots in the NNNTeZ (North North North Temperate Zone) with what appears to be a closely associated white spot near the southern edge of the NPR.

Somewhat elongated white streaks have been reported in the EB (Equatorial Belt). The aforementioned white spots have persisted and have shown up well in images captured with RGB, 685nmIR, and red filters.

It will be extremely worthwhile to continue to monitor Saturn to determine the longevity and changing morphology of these features for the remainder of the apparition. Observers should be watchful for any new atmospheric phenomena that might suddenly appear. With the rings tilted as much as +26° toward our line of sight from Earth in 2018-19, observers still have near-optimum views of the northern hemisphere of the globe

Geocentric Phenomena for the 2018-19 Apparition of Saturn in Universal Time (UT)

Conjunction	2017 Dec 21^{d} UT
Opposition	2018 Jun 27^{d}
Conjunction	2019 Jan 02^{d}
Opposition Data for June 27, 2018:	
Equatorial Diameter Globe	18.3″
Polar Diameter Globe	161″
Major Axis of Rings	41.5″
Minor Axis of Rings	18.2″
Visual Magnitude (m_v)	0.0
B = Declination Constellation	+26.0° -22.5° Ophiuchus

Inside the ALPO
Member, section and activity news

and north face of the rings during the apparition.

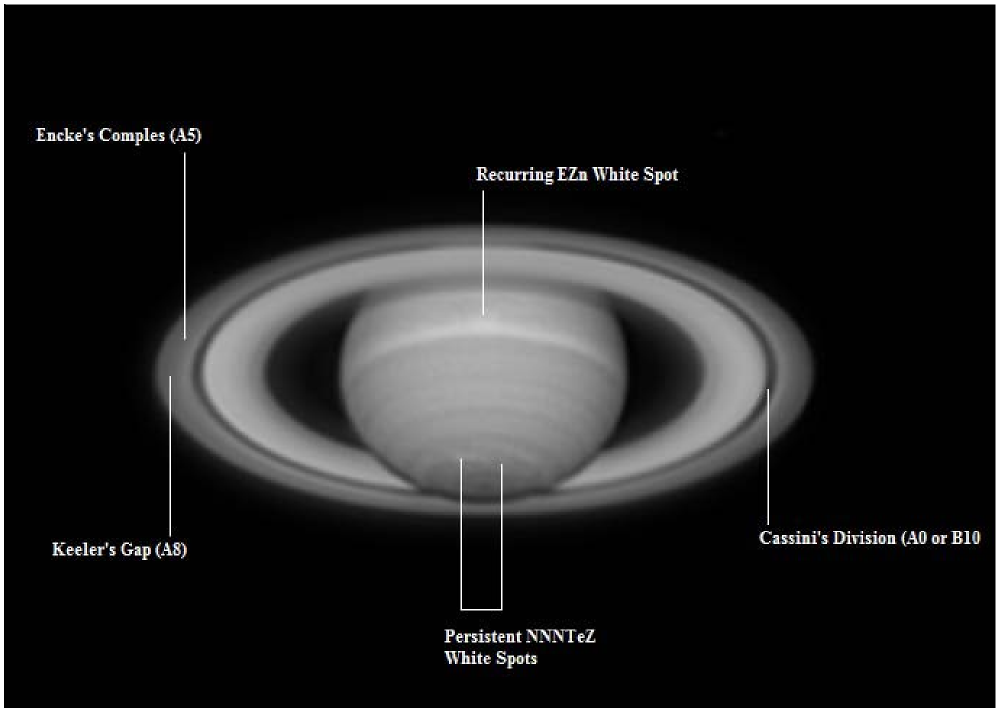
Pro-Am cooperation with the Cassini mission continued during the previous 2016-17 apparition as NASA's unprecedented close-range surveillance of the planet for nearly thirteen years that started back on April 1, 2004, and concluded its remarkable odyssey on last year on September 15, when it plunged into Saturn's atmosphere.

For years to come, however, planetary scientists are carefully studying the vast database of images and data gleaned from the Cassini mission, Pro-Am efforts will not cease in 2018-19 as we regularly monitor atmospheric phenomena on Saturn and actively share our results and images with the professional community. Thus, anyone who wants to join us in our observational endeavors is highly encouraged to submit systematic observations and digital images of the planet at various wavelengths throughout the new 2018-19 apparition as well as during the next observing season.

Observers are also reminded that visual numerical relative intensity estimates (also known as visual photometry) remain an important part of our visual observing program and are badly needed to ascertain recurring brightness variations in the belts and zones on Saturn as well as the major ring components.

ALPO Saturn observing programs are listed on the Saturn page of the ALPO website at http://www.alpo-astronomy.org/saturn as well as in more detail in the author's book, *Saturn and How to Observe It*, available from Springer, Amazon.com, etc., or by writing to the ALPO Saturn Section for further information.

Observers are urged to pursue digital imaging of Saturn at the same time that others are imaging or visually monitoring the planet (that is, simultaneous observations). Also, while regular imaging of the Saturn is very important, far too many experienced observers neglect making visual numerical relative intensity estimates, which are badly needed for a continuing comparative analysis of belt, zone, and ring component brightness variations over time.



Excellent image of Saturn taken by Trevor Barry of Broken Hill, Australia, June 30, 2018 at 12:13:24 UT. His red channel image was captured in fair seeing (S = 5.0) using a 40.8 cm (16.0 in.) Newtonian reflector. His image shows the recurring diffuse white spot within the EZn adjacent to the EB, plus a string of long-lived white spots in Saturn's NNNTeZ (North North North Temperate Zone) and possibly at the southern edge of the NPR (North Polar Region). Cassini's division (A0 or B10) is quite obvious, running all the way around the circumference of the rings except where the globe blocks our view of the rings. Also seen are Keeler's gap (A8) and Encke's “complex” (A5), as well as a few possible “intensity minima” at the ring ansae. The north polar hexagon is also barely visible. The apparent diameter of Saturn's globe was 18.3" with a ring tilt of +26.0°. CMI = 1.7°, CMII = 213.8°, CMIII = 280.7°. Visual magnitude +0.0 and South is at the top of the image.

The ALPO Saturn Section thanks all observers for their dedication and perseverance in regularly submitting so many excellent reports and images. *Cassini* mission scientists, as well as other professional specialists, continue to request drawings, digital images, and supporting data from amateur observers around the globe in an active Pro-Am cooperative effort.

Information on ALPO Saturn programs, including observing forms and instructions, can be found on the Saturn pages on the official ALPO Website at www.alpo-astronomy.org/saturn

All are invited to also subscribe to the Saturn e-mail discussion group at Saturn-ALPO@yahoogroups.com

Inside the ALPO
Member, section and activity news

Remote Planets Section

Report by Richard W. Schmude, Jr., section coordinator
schmude@gordonstate.edu

Uranus and Neptune will be visible nearly all night in early October, so this will be your best opportunity to observe both planets. I have attributed my own success to finding these difficult objects to the use of binoculars.

Therefore, if you plan to use a telescope, I suggest that you first look at a star chart illustrating the position of the target, then use binoculars to find the target. [Editor's Note: *skyandtelescope.com* is a great source to find specific locations of sky objects.]

Once this is done, find the target in the finder scope of your telescope. Finally, use a low-power eyepiece and find it in the telescope.

Note that you may need a dark site to locate Neptune in binoculars and in the finder scope.

Observer Manos Kardasis of Athens, Greece, has already submitted one image of Neptune that shows a bright south polar region. This writer (Schmude) has attempted to measure ultraviolet brightness measurements of Neptune during July.

The writer has also just completed work on the 2017-2018 apparition report and have submitted it for publication in this Journal.

Finally, a reminder that the book *Uranus, Neptune and Pluto and How to Observe Them*, which was authored by this coordinator, is available from Springer at *www.springer.com/astronomy/popular+astronomy/book/978-0-387-76601-0* or elsewhere (such as *www.amazon.ca/Uranus-Neptune-Pluto-Observe-Them/dp/0387766014*) to order a copy.

Visit the ALPO Remote Planets Section online at *www.alpoastronomy.org/remote*

Notable Deaths

John Westfall
August 16, 1938 – July 26, 2018

By William Sheehan, with contributions from Elizabeth Westfall, Matthew Will, Robert Minor, Robert Garfinkle and Alberto Gomez. This work was originally published on the American Astronomical Society website, which also includes various references cited by Mr. Sheehan.

Also included here are tributes published on both the ALPO discussion list and the Higgins Funeral Chapel online tribute site.

- Professor of Geography and Environmental Sciences at San Francisco State University, 1968 – 2005.
- Ph.D, The George Washington University; BA and MA, University of California, Berkeley.
- Director of the Association of Lunar and Planetary Observers, 1985 – 1995

John Westfall, geographer, academic, amateur astronomer, author, and world traveler, passed away on the 26 July 2018. John was a gentleman and a scholar, in the best sense. His accomplishments were exceedingly diverse, but because of his modesty he was reluctant to talk about them, so his career is not easy to summarize. Professionally, he was a geographer, receiving his B.A. at the University of California, Berkeley and his M.A. and Ph.D. in Geography at the George Washington University, and served as Professor of Geography and Environmental Sciences at San Francisco State University from 1968 to 2005. His real interest was, however, astronomy, which began at a very early age.

Elizabeth & John Westfall at the SAS-ALPO Conference. *Photo by Matt Will.*

According to John's own account (published in *The Refractor*, 16 August 2016):

> *"Oddly, I can remember what started my fascination with astronomy: it was the photograph of Saturn in the 1931 edition of the Lincoln Library of Essential Information. I ran across the eye-catching photo in 1945, when I was seven. It prompted me to find out the address of Chabot Observatory, in my then home city of Oakland [California], allowing me to write a letter (unstamped) to its Director, Earle Garfield Linsley (1882-1969, Director 1923-47). The kind Professor Linsley introduced me to both the Chabot Observatory and the Eastbay Astronomical*

Inside the ALPO

Member, section and activity news

Association (as it was then named), which I joined as its ever-youngest (if not ever-young) member in February 1946. Thus, 1945-46 were an exciting couple of years. They even included the greatest meteor shower (actually meteor storm) I've ever seen, the Draconids of October 9th, 1946. Somehow, probably through Prof. Linsley, my father took us to our backyard where we watched an ongoing natural fireworks display (estimates gave up to 10,000 meteors per hour); the only problem is that all subsequent meteor showers have seemed tame to me!"

Thus, while still wet behind the ears, John became a regular at meetings of the Eastbay Astronomical Association (which became the Eastbay Astronomical Society after 1949), which held its monthly meetings at Chabot. His interest was also encouraged by his parents, who paid for a subscription to *Sky and Telescope* in 1952, and membership dues of the British Astronomical Association and the Royal Astronomical Society of Canada. They also acquired for him a 3 ½-inch Skyscope reflector, which he trained every clear night on the Moon and planets.

As with most precocious youths, for a number of years most of his contacts were with much older individuals. In those days—long before the Internet—the only way to come into contact with others of similar interests was by letter-writing or attending meetings. He finally met some amateur astronomers in his own age group at conventions of the young Western Amateur Astronomers in Berkeley in 1952 and Flagstaff in 1956. Meanwhile, he had outgrown the 3 ½-inch Skyscope reflector. By 1954 was observing with a 4-inch Tinsley Saturn refractor—his primary observing instrument from 1954 until 1968 when he obtained a 10-inch Cave Astrola. He supplemented his backyard observing with sessions at Chabot, using the 8-in. Alvan Clark and 20-in. Brashear/ Warner & Swasey refractor to observe Mars at the June 1954 and September 1956 oppositions.

Those were heady days in which to be young and a budding amateur astronomer. Interest in Mars was again very high—and books like Robert S. Richardson's *Exploring Mars* stoked the fires of enthusiasm, by providing considerable encouragement to the idea that there might be at least primitive lifeforms on the planet (as was believed by the majority of even sober astronomers at the time). The British amateur astronomer and prolific popular astronomy writer Patrick Moore was beginning to make a great impression with books like *Guide to the Moon*, *Guide to the Planets*, *Guide to Mars*, *The Planet Venus*. Also, the first Earth satellite (Sputnik in 1957) and probes to the Moon (the Luniks of 1958 and 1959) were being launched.

It was inevitable that at such a time a young person taking up astronomy would be most captivated by the Moon and planets, and so it was with the young John Westfall. That interest was, moreover, greatly stimulated when, in 1953, he discovered the Association of Lunar and Planetary Observers (ALPO), which had been founded in 1947 by Walter H. Haas (1917-2015). John wrote a letter expressing his desire to become a member, and much as Eric Linsley had done previously, Walter Haas became an indispensable mentor and lifelong friend. And so, John began what would be a lifetime of dedicated service to the organization which meant more to him than any other. He held many official positions, including: Recorder for the Lunar Section (General) from 1962 to 1993, Recorder/Coordinator of the Mercury/ Venus Transit Section 1993 until his death, Recorder/Coordinator Jupiter Section (Galilean Eclipse Timings) 1981-2018. He was Associate Director of the ALPO from 1977 until 1985, Director from 1985 to 1990 and Executive Director (following ALPO's incorporation in 1990) from 1990 to 1995, Editor of the Journal from 1985 to 2000, and Board Director from 1990 until his death. He was an avid member of other astronomical organizations; for instance, he attended, for some twenty-five years, the NCHALADA (Northern California Historical and Lunch and Discussion Association) to discuss topics in the history of astronomy, and also made it a priority to attend the Lunar and Planetary Science Conferences at the Woodlands (near Houston) in Texas every year.

Very early in his career, John developed what would always be his chief research interest– eclipses, transits, and occultations. At the age of only 19, John made some exceptionally valuable observations of a stellar occultation by Saturn's rings with the 20-inch Brashear refractor at Chabot on 27 April 1957. Such events are rare, and in the pre-spacecraft era they were the best source of information about the structure of the rings. Nowadays, of course, occultations of stars and radio signals from spacecraft have become commonplace, but at the time John observed this event, there had been only two previous ones in the history of Saturn observations: the first was observed in 1917 by the British observers James Knight and Maurice A. Ainslie (1869-1951), and was called by Saturn historian A.F.O.D. Alexander, "one of the greatest triumphs ever achieved by observers of Saturn in Great Britain." The other was observed by meteor astronomer Frederick C. Leonard (1896-1960) at Griffith Observatory in 1939. John's observations at the April 1957 occultation were carried out with meticulous care, and the professional Russian astronomer Mar Sergeevich Bobrov (1914-1990) based an analysis on them showing that the A ring was partly transparent, as were at least portions of the B ring. Indeed, John's results continued to be cited in standard works on the rings right up until the spacecraft era (see Elliott and Kerr, Rings, pp. 33-34).

Apart from his continuing involvement in ALPO, John's astronomical activities were curtailed to a certain extent between 1960

Inside the ALPO
Member, section and activity news

and 1968, while he was living in the Washington, D.C. area, employed by the Coast and Geodetic Survey (now the U.S. National Geodetic Survey) and attending the George Washington University while working toward his master's and doctorate degrees in geography. He did, however, take advantage of being located on the East Coast to travel to Maine for his first total eclipse of the Sun, on 20 July 1963. (No one could then have guessed that in only six years to the day, humans would set foot on the Moon.)

John's professional training in geodesy and mapping, which he pursued as a professor of geography and environmental sciences at San Francisco State University between 1968 and his retirement in 2005, worked hand in glove with his interests in amateur astronomy. For instance, he led the systematic and coordinated effort to map the South Polar Region of the Moon, a region which had been hidden in shadow during the Lunar Orbiter missions of the 1960s. A number of talented observers had made attempts to map this region, which includes in part the huge South Pole-Aitken basin (after the Hellas basin on Mars, the largest basin known anywhere in the Solar System). One was the celebrated selenographer Ewen A. Whitaker (1922-2016) who had carried out preliminary surveillance while still at the Royal Greenwich Observatory in the 1950s; he was drawn to the limb regions by the fact that they looked rather if they were being viewed from an orbiting spacecraft! Another was the noted British amateur astronomer and artist Harold Hill (1920-2005) who worked on the project for several decades but—owing in part to his very rigorous standards—failed to finish. Westfall, in collaboration with his associates, succeeded: he completed a map in the early 1990s. It merits comparison with maps carried out by Clementine and more recent spacecraft.

As noted earlier, eclipses, transits and occultations were John's chef-d'oeuvre. As an eclipse chaser, he started out slowly—at first traveling only to those that were geographically close at hand, such as the 20 July 1963 eclipse, observed from the coast of Maine as noted above, and the 26 February 1979 eclipse from Yakima Valley, Washington. From 1988, however, he began to make up for lost time, and eventually logged thirteen total eclipses, as well as four annular eclipses. (See table of John's observed eclipses at *https://aas.org/obituaries/john-e-westfall-1938-2018*). It was a source of deep regret that, owing to illness, he was unable to see the "Great American Eclipse" of 21 August 2017.

Though as addicted to the thrill of totality as anyone else, John was, more than most, an eclipse egalitarian, and also avidly pursued annular eclipses as well as less dramatic events, such as lunar eclipses and Galilean satellite phenomena. Lunar eclipses were always meticulously observed. He always made careful timings of the progress of the Moon's shadow across designated craters and observed the depth of darkness (using the Danjon scale) and colors. By this means he was to discern changes in the Earth's atmosphere, with results bearing on the question of climate change (in which he, of course, believed). He systematically tabulated and analyzed Galilean satellite eclipses, transits, and occultations for the ALPO. He was also a keen student of the "mini-eclipses" known as transits of Mercury and Venus, and was one of the world's leading experts on the history and observation of these phenomena. Though even in the case of Venus, whose diameter during transit is only 1 minute of arc, the effect is more cerebral than visceral, nevertheless, the importance of these events in the history of astronomy, and in particular their historical role in measuring the solar parallax, made them irresistible for John, and combined several of his principal interests.

John and his wife Beth travelled to far points of the globe to view transits, no less than eclipses. For the transit of Mercury of 6 November 1993, they went to Coonabarabran, Australia. For both the transit of Mercury of 7 May 2003 and the transit of Venus of 8 June 2004, their destination was Lemeso, Cyprus. (The island was particularly fitting, given its ancient associations with the goddess sometimes known as the "Cyprian".) The transit of Venus of 6 June 2012 was visible from his private observatory in Antioch, California, and therefore could be studied with the instruments of his own observatory (of which the principal telescope was a 25.4-cm f/16.5 Cassegrain telescope, specifically designed for Solar System observations).

John was co-author of two books that deal with the transits. The first (with William Sheehan) is *Transits of Venus* (2004), of which Harvard University historian Owen Gingerich said, "For 40 years the standard account of this rare phenomenon has been the late Harry Woolf's doctoral dissertation, The *Transits of Venus*, published in 1959…. Now, in an engaging account … Woolf's monograph is at long last superseded." The second is *Celestial Shadows* (2015, also with William Sheehan), which although it treats transits of Venus also extensively treats the whole range of eclipse, satellite, and transit phenomena in the Solar System—indeed, in the era of extrasolar planet discovery, beyond. John regarded the latter as his magnum opus; it is hoped that it will be appreciated as a standard reference work for a long time to come.

Incidentally—and perhaps surprisingly, given the depth and extent of our collaborations--John and I met in person only twice: once in San Francisco in 2001 or so, and once in Flagstaff, Arizona, in 1994, although that one escaped John's memory. We also spoke, as far as I can remember, only once on the phone. Otherwise our collaboration was entirely by "snail mail" (in the old days) or by e-mail once that became the norm. I have a large folder of letters from John, and a few hard copies of e-mails. The world is obviously a very different place indeed from what it was in 1946, when John joined the Eastbay Astronomy Association and when personal—face to face—contact with

Inside the ALPO
Member, section and activity news

specialists and other enthusiasts was an indispensable part of advancing in one's hobby or career.

Wife Beth was not only John's co-traveler on global expeditions, but also eagerly—or at least gamely--agreed to play the role of proofreader of every book and article that John ever wrote, and little escaped her keen eye. Having myself collaborated with John on two of the three books he wrote (his third, *The Atlas of the Lunar Terminator*, had been published in 2000), I can say that he was an ideal co-author; we brought out the best in each other. John could always be counted on for an encyclopaedic knowledge of detail, the ability to track down every possible relevant reference, and an amazing deftness in putting together tables of data (fully analyzed, of course), expertly drawn maps, and lucid diagrams. Furthermore, he was always patient, and had a genius for taking infinite pains. He also had a penchant for coming up with witty and humorous sub-headings and elegant turns of phrase to leaven long tracts dense with data and detail. Everyone who knew him attests to his delightful (if dry) sense of humor.

Astronomical events such as eclipses and transits were, in some respects, mere excuses to travel the globe—and thus to advance John's (and Beth's) absorbing interest in geography and history. Beth recalls, "Wherever we went … there were always sites associated with the history of astronomy to be visited. Because I loved history, although different periods and topics, we were excellent travel companions. Each could enjoy the topics of interest to the other. Early in our adventures we developed a working relationship. We planned the trips together. John took the lead in determining the itinerary and special sites to visit. I arranged the details to make the plan work. I was the driver and he the navigator. In Britain, in Turkey, in Spain, in Finland, in Australia, in Fiji, we would start down a dirt road to a site he had identified. The paved road turned to dirt, then got progressively narrower. 'Are you sure this is the right road?' I would ask. Buried in his maps and air photographs, he would say, 'Yes, keep going.' And we always found what we were looking for."

One of John's particular heroes, associated with the 1769 transit of Venus, was Jean-Baptiste Chappe d'Autoroche, who observed the transit at Cabo San Lucas, Baja California, and died soon afterward (probably of typhus). Beth recalls this visit, which was undertaken when they were in Baja for the 11 July 1991 total eclipse. "Working from a sketch that one of Chappe's men had made and studying topographical maps, John triangulated the ridgeline of the drawing with the ridgeline of the hills, and he was confident that he had located the spot." She adds: "Today that could not be done; the ridges are covered with condos." During a visit to Hawaii, they were not to be found on the beaches, but searching out the plaques marking the observing sites for the total eclipse of 3 June 1850 (the last visible there until 11 July 1991). The Westfalls' travel itinerary included many historic observatories, including Lick on Mt. Hamilton, near San Jose, California, Lowell in Flagstaff, Arizona, Greenwich and Herstmonceaux in Britain, Pulkova in Russia, the observatory in Rio de Janeiro, the Archenhold Sternwarte in Berlin and many others. John counted as one of his greatest privileges being treated to a personal visit of Clyde Tombaugh's personal observatory in Las Cruces, New Mexico, with Clyde's home-made mounting and viewing deck. Also, beginning in 2013, John joined a small group of like-minded individuals, mostly from the San Francisco Bay area, for annual observing sessions with the 60-inch reflector at Mt. Wilson. As was typical with John, he always went thoroughly prepared with an extensive program of ephemerides, notes, diagrams and maps of what was to be seen. He prepared such a program for the latest—June 2018—get-together, which however he was sadly unable to attend.

Other places with astronomical tie-ins were the Nördlinger Ries and Steinheim craters in southern Germany, which had been identified as impact craters by close friend Eugene M. Shoemaker (1928-1997), and Gosses Bluff impact crater in the Australian outback, which they viewed from a light plane. The Odessa crater, at Odessa, Texas, also made the list.

John, obviously, had a streak of obsessive-compulsiveness, and a decided dislike for incomplete series. For instance, after viewing the Goldstone and Canberra tracking stations belonging to the NASA Deep Space Network, only one—Madrid—remained. John and Beth finally added it in 2003, when they went to Madrid for the Annular Eclipse that year.

John enjoyed science fiction and historical fiction such as the novels about Falco, a 1st Century Roman "detective" (by Lindsey Davis). His favorite author was, however, H. P. Lovecraft (1890-1937), and for many years, he produced a Lovecraft-themed calendar which he would send during the holiday season as a gift to (carefully vetted and select) friends. Well aware of the fact that Lovecraft identified his fictional Yuggoth with Pluto when the latter was discovered in 1930, John was of the opinion that Lovecraftian names ought to be adopted for all the features discovered by the *New Horizons* probe during its July 2015 flyby, and—knowing that I was a member of the Working Group for Planetary System Nomenclature (WGPSN)—painstakingly compiled, for my benefit and for the benefit of other members of the group, a list of hundreds of Lovecraftian names for possible inclusion. So far only one of them has made it onto Pluto: Chthulu Macula is the name officially adopted by the IAU for an elongated dark region along Pluto's equator. Needless to say, John was delighted by that one.

In spite of illness, John remained alert and active to the very end. Though he would miss the eclipse of 21 August 2017, he was able to attend his last ALPO annual meeting in June 2018. I received my last communication from him less than two weeks before he died. For some years he had been working, with Al Gomez (Spain)

Inside the ALPO
Member, section and activity news

and me, on a project combining several of his keenest interests—the lunar terminator, eclipses, and the calculation of distances in the Solar System. We were interested in exploring how well Aristarchos of Samos (or someone of his time) might have measured the Earth—Moon—Sun angle at the time the Moon was noted to be exactly half. John personally invented and put together an ingenious device for the purpose, called a dichometer, and made a long series of lunar terminator observations, which he summarized in a masterly paper—completed shortly before his death, when he was, however, too ill and weak to submit it for publication. Fortunately, it will appear in the *Journal of the Association of Lunar and Planetary Observers*, as he undoubtedly would have wished. It is a minor masterpiece, and a monument to this brilliant, modest, latter-day Aristarchos.

Writing his own epitaph, Johannes Kepler wrote: "Once I measured the heavens, now I measure the Earth's shadows." John Westfall would have appreciated the sentiment. Few have ever measured the heavens—or the Earth's shadows—better than he. If it is possible to measure the shadows wherever he is now, I am sure that he will find a way.

Remembrances from others

Very sad news indeed.

John's good company, considerable expertise, and quick wit will be missed greatly by all of us.

— Alan Agrawal

John was a well known contributor to ALPO both scientifically and to our organization. He was an excellent writer and editor, a meticulous recorder of astronomical phenomena, and was one of the most helpful ALPO members for me all the year I knew him; he also put up with our jokes with grace. R.I.P. my friend, John Westfall."

— Jeff Beish
ALPO member (from his announcement on the Cloudy Night forum)

John Westfall was a fine fellow as well as a fine scientist. My wife Hilary and I met him and Beth through our mutual friends Stephen and Grania Davis, sometime back in the 20th century. He was known for his terrific astronomical photography and in particular for his book on the lunar terminator. It is always a pleasure to converse with him. He will be missed.

— Jim Benford

John Westfall was a longtime special friend and colleague who I first corresponded with back in 1969 right after I joined the ALPO. His always meaningful encouragement and guidance for contributing visual observations of the Moon and planets inspired me to do even more serious visual work and photography in support of ALPO programs. John was always willing to critique my observational results and kindly point out ways I could improve the accuracy and scientific value of my submitted data. John was especially helpful to me with lunar observations, and he encouraged me to take on more leadership responsibilities, leading to my appointment as the Lunar Recorder for Selected Areas program back in 1972. His unique sense of humor made attending ALPO annual meetings especially enjoyable over the years. Serving with John on our board of directors was always enlightening, and memories of his unfailing dedication to the ALPO will inspire and stay with me for the rest of my life. I will deeply miss the times I spent together with John, truly a loyal fiend who I will never forget as I whenever I observe the Moon and watch mutual phenomena of Jupiter's moons.

Rest in peace my beloved colleague.

— Julius Benton
board member, coordinator, ALPO Venus Section and Saturn Section

So sorry to hear that John has passed. I knew him only briefly through the ALPO and got to meet him at the ALPO convention of 1991 in La Paz, Baja California, Mexico, for the memorable total eclipse of the Sun. He certainly was modest, especially given his many accomplishments.

— Klaus Brasch

It is with some shock and surprise that I received the sad news. Although I did not know John well, I had been working with him over the past months to scan past issues of the ALPO Journal that he has provided. In the last week, while scanning through issues from 1963 and 1964 I noticed his many Journal contributions and have been thinking of him often. It is some small comfort to think that his many articles are becoming available to all ALPO members and to astronomers worldwide.

I hope that the issues that have been scanned so far can serve as a lasting tribute to John and other ALPO members.

— Shawn Dilles
ALPO member

It was with a great sense of loss that I (learned of John's passing). We connected way back when, I think it was 1953, at a WAA conference at Berkeley and have been fast friends ever since. I found John to be a gracious host, showing us through the observatory on the Berkeley campus as well as the old Chabot Observatory in Oakland. It was always a pleasure to reconnect periodically at WAA and ALPO meetings over time. I probably should have kept up more frequent correspondence in recent times, but we did connect several times in the recent past. I fondly recall those various visits at Berkeley and the Chabot Observatory and the bull sessions with John, sometimes far into the night. He will be sorely missed, but never forgotten.

Inside the ALPO
Member, section and activity news

— F. Jack East man
ALPO member

Over the past few months, ALPO has lost two of its best expert lunar observers/historians – Richard Baum and now John Westfall. I first met John in the early 1990s while waiting for the publication of my first astronomy book, *Star-Hopping: Your Visa to Viewing the Universe*. I was just starting my lunar observers handbook then and he asked me what I was planning on covering in the book. John started suggesting what other lunar topics I should include and as a result of his suggestions, *Luna Cognita* kept growing. It is now 1,870 typeset pages and over 1,113,000 words. I hope to have it in bookstores next year.

John offered to review parts of the manuscript. About the best thing that I can say about John is that he was the best nitpicker ever and I say that with love for him. He carefully read everything and double-checked not only the manuscript text, but also every lunar coordinate in every cell in the tables that I asked him to review. I will forever be in debt to his meticulous efforts to not only make sure that everything on the pages that he looked at is correct, but he even wrote the preface for *Luna Cognita*.

Thanks John, for being not only one of my proofreaders but also a great friend.

— Bob Garfinkle, FRAS
ALPO book review editor

Beth, so sorry for your/our loss, I had an interesting talk with John about meteor showers at ALCON 2016, forever cherished.

— Vince Giovannone,
ALPO member

Wherever you've gone, you've taken a bit of me with you.

— Alberto Gomez

I am so sorry to hear this. Condolences to the family.

— Kim Hay,
former coordinator, ALPO Solar Section

I am sorry to hear this sad news and offer my condolences. John made amazing contributions to the ALPO both scientifically and to the organization.

— Dolores Hill,
coordinator, ALPO Meteorites Section

I just got on email and saw this. I am very sorry to (learn of John's passing) and had no idea things were this serious. I had known him for quite awhile, back into the 1970s, and I'll miss his expertise on science fiction and lunar topics. I'm glad we had some time together during the 2015 AL/ALPO meeting.

— Rik Hill
coordinator, ALPO Solar Section

Soooo sad to hear the news. John was a gentle, scholarly man who contributed greatly to our NCHALADA meetings. I really enjoyed talking with him about the various Humanities West conferences we attended. I will really miss him!

— Nick Kanas

I'm sorrowful at this news. I worked long years with John on his project “Luna Incognita”.

All my condolences for his wife Beth, and all the ALPO staff.

— Michel Legrand
ALPO member

I am sorry to hear the sad news. I contacted John few times and received his kindly replies. He also knew my astronomical work on the subject of minor planet 139 Juewa.

Asteroid 28602 was named after him in honor of his contribution. He should explore the vast universe on that asteroid. Let us memory him.

— Jingming Lin
ALPO member (China)

This is indeed very sad news, as John was the first to reach out to me and convince me to join the ALPO back in the 1980's. My condolences to the Westfall family. John will sorely be missed by all.

— Bob Lunsford
coordinator, ALPO Meteors Section

This is sad. John was a neat guy who helped me get into the indexing of the JALPO back in the early '90's. I will miss his interesting talks at the meetings and personal meet-ups.

— Mike Mattei
ALPO member

Thank-you, John, for believing in me and understanding my many moods. You will be missed.

— Paul Maxson
ALPO member

Wow! This is truly the end of an era! John Westfall was a true inspiration!

— John W. McAnally
coordinator, ALPO Jupiter Transit Timings Program

We never met but corresponded several times and (found that) he had an impressive ability in math as well as an observing. I did write to him earlier in the year and the lack of a reply made me wonder if he was unwell. I recall his amazing 1970s study of the relief in Aristarchus, which involved filling a plaster model with water, if I recall correctly. I once consulted John about the method of finding the height of a Martian terminator projection. I received a very rapid and detailed reply which was most helpful in clarifying the problem. He had a distinct ability in analyzing this and other problems, breaking them into a clear sequence of mathematical steps. The Alpo is much the poorer for his loss.

— Richard McKim
ALPO member

Inside the ALPO
Member, section and activity news

I'm sorry to hear about John Westfall's passing. He was one of the first members I knew when I first joined the ALPO group back in the earlier 1980s. For more than 15 years, we were writing letters back and forth and he encouraged me on many projects to observe. Then I met him for the very first time at the ALPO meeting in 2001. He was always there at every meeting I attended afterward. He was very intelligent and I always enjoyed his conversation.

As a great friend, a great astronomer, a great geographer, a great ALPO member and a great person, he will be sorely missed...

— Frank J Melillo,
coordinator ALPO Mercury Section

My sympathy to John's family at his passing, and gratitude for his many years of contribution to the ALPO.

Ray Missert,
ALPO member

Sorry to learn of John's passing. We are both in the same boat now.

— Derald Nye
ALPO member

John was one great guy, always thoughtful and full of insight. I remember meeting and having dinner with him many years ago. He was a very good listener and would give his honest opinion. His hard work on the ALPO Journal (*The Strolling Astronomer*), was exemplary. A valuable asset of the amateur astronomical community and friend to all, has passed.

Much Love to his family and extended family as well.

— Jim Phillips
acting assistant coordinator
ALPO Lunar Domes Program

I am deeply saddened to hear of John's passing. It was a privilege to spend time with both John & Beth at the many ALPO meetings since 1993 and at various eclipses.

My condolences to Beth and the rest of the Westfall family.

The next time I aim a telescope at the Moon or spy on Jupiter's moons, I will think of John, as a tribute to his legacy.

I hope that all ALPO members will do the same. It's in this way that so many of the great mentors live on in our hearts and minds.

— Phil Plante,
ALPO member

His intelligence, his calm demeanor, his knowledge, his willingness to help in any way -- all of these are things that I associate with him. I seem to recall that he never got excited, and if he did, no one could tell. He was one person you'd want to be with when things got bad.

— Ken Poshedly
editor & publisher, *Journal of the ALPO*

Farewell John, thanks for all of the encouragement during my early years into exploring the solar system.

— John D. Sabia
ALPO member

John Westfall appointed me as the coordinator of the ALPO Remote Planets section back in November1990. He also sent me some of his early brightness measurements of the remote planets. I believe that I first met him at the Cosmocon 1992 convention in San Jose, California. I was able to visit with him at the SAS-ALPO joint meeting in June 2018. John was very knowledgeable about the Moon and planets. He was in charge of the Galilean Eclipse program of the ALPO Jupiter Section for many years. He consistently provided excellent reports of visual Galilean satellite eclipses. In 2017, I learned that he was suffering from leukemia. He will be greatly missed.

— Richard Schmude
executive director, the ALPO

Very sad -- John was especially helpful to me as I struggled to take over a couple of *Sky &Telescope* projects after Joe Ashbrook died in 1980. These involved collecting crater timings made during lunar eclipses, and collecting timings of Jupiter's satellites entering or leaving eclipses by Jupiter itself. John graciously shared ALPO observations with us and offered much encouragement.

— Roger Sinnott
***Sky & Telescope* magazine**

It is with great sadness that I reflect on John Westfall's passing. John Westfall was one of those persons that had a unique blend of talents and perspectives that he applied to amateur astronomy and the ALPO. John was an excellent writer and editor, a meticulous recorder of astronomical phenomena, and a mentoring influence in not just publishing his astronomical works, but giving individuals like myself the personal attention I needed when starting out in amateur astronomy, a long time ago.

It was through the leadership of John and his wife Beth that the ALPO was able to reestablish itself in 1990 under a more solid footing as a corporation with the security and legal status that it brought to the organization. John's legacy for the ALPO as the leading amateur research organization will continue on thanks to the faithful diligence and vision that he provided over his long tenure with the ALPO.

— Matthew Will
membership secretary & treasurer, the ALPO

I never met John but exchanged some letters (pre-email days) and shared his passion for the Moon.

— Chuck Wood
noted lunar author & webmaster for *Lunar Photo of the Day*

Feature Story:
ALPO Board Meeting Minutes, Ontario, California, Friday, June 15, 2018

Meeting minutes provided by
Matt Will, ALPO Secretary / Treasurer
matt.will@alpo-astronomy.org

Call to Order

On Friday, June 15, 2018 at 7:34 p.m. PDT (Pacific Daylight Time), ALPO Executive Director and Board Chairman Richard W. Schmude, Jr. called the ALPO Board of Directors meeting to order in the Breakout Room of the Ontario Airport Hotel, located in Ontario, California. The ALPO Board meeting was held during the 2018 Society for Astronomical Sciences Symposium, where the ALPO participated in its paper presentation sessions held on June 15th and 16th.

ALPO Board members Richard W. Schmude, Jr. (Executive Director and Chairman), Matthew L. Will (Corporation Secretary and Treasurer) and Board member John E. Westfall were present and in person at the Board meeting with Board members Julius L. Benton, Jr., Kenneth T. Poshedly, and Michael D. Reynolds participating via our AT&T teleconference line away from the meeting site. Board member Sanjay Limaye could not attend or participate in this year's annual meeting due to prior commitments. Also in attendance were ALPO Training Program Coordinator and ALPO Podcast Host Tim Robertson, Lunar Impacts Coordinator Brian Cudnik, and ALPO members Phil Plante and Jim Fox. A guest, (now ALPO member) Leonard Vorhis, also attended the meeting in person.

Issue One: Approval of the Board Meeting Minutes of 2017

(Introduced by Matthew Will)

The Board meeting minutes for our 2017 ALPO Board meeting were approved by all the Board members last fall.

Issue Two: Review of ALPO Finances and Endowment

(Introduced by Matthew Will)

ALPO Secretary and Treasurer Matthew Will submitted to the ALPO Board the annual treasurer's report last February, in addition to a supplemental report to the Board in late May. The ALPO had a surplus of $1,895.45 in income at the end of 2017. This was mainly due to the fact that only three printing cycles for the Journal occurred in 2017 as opposed to five in 2016. Else, we would have incurred a slight deficit in year 2017 if we had four printing cycles reported over that period of time. While the ALPO still produced the usual four seasonal Journal issues for 2017, the billing cycles were uneven in 2016 and 2017.

The treasurer's interim report for 2018 did report a current deficit of $3,597.28, which is larger than normally expected for this time of year. While the ALPO experiences some high-end expenses at the beginning of the year which isn't unusual, the higher-than-usual deficit can be attributed to an unanticipated eight-fold increase in the cost of maintaining the ALPO website. This was mainly due to covering current practices on our website that our internet provider was not initially aware of and were not covered under the past plan the ALPO was paying for.

To make things right, and to provide a service that could be expandable for future use of the website, the ALPO

ALPO Executive Director Richard Schmude and ALPO member Phil Plante. *All photos by Matt Will.*

Board felt it was essential for the ALPO to have a fully functioning website that could provide not only a resource for information about the ALPO, but to provide a means for collecting observational data as well. To make up the difference in a projected year-ending deficit, the treasurer recommended a dues increase to meet the additional burden of cost for the website and other costs related to publication of the Journal. The accompanying table presents the proposed dues increases.

Higher level memberships beyond "regular" will not be affected by the dues increase.

Proposed Membership Dues Change for January 1, 2019

	One Year	Two Year	Lifetime
Regular Paper Domestic	$45	$84	---
Regular Paper International	$52	$98	---
Regular Digital	$18	$32	---
Sustaining Member	$75	---	---
Sponsor	$150	---	---
Patron	$250	---	---
Benefactor	$500	---	---
Provider	$1,000	---	---
Funder	$2,500	---	---
Universal	---	---	$10,000

To help out with publication of the Journal and other organizational costs, Ken talked about the possibility of applying for grants from such sources as the National Science Foundation and private foundations to supplement income for the publication of the Journal. Matt commented that grant writing can be a very intensive and time-consuming process that requires much content from the applicant and is not merely a matter of filling out forms. Grant packages submitted to a foundation can run for many pages covering such issues as a business plan for the organization, independently audited financial information about the organization, and other internal information including Board and staff biographies.

Having been involved in past grant submittals in the educational field, Mike Reynolds agreed with Matt's assessment but said that boiler plate language could be developed for the first grant package and could be used for subsequent grant submittals in the future. Mike agreed to assist Ken and Matt through this process in developing a comprehensive grant package in the future.

All Board members agreed that the possibility of grants is a future item to be researched and developed on a longer term track and did not affect the immediate need to adjust income to support the Journal and organizational expenses presently. Matt Will made a motion to increase the ALPO membership dues as recommended in the table above. John Westfall seconded. The ALPO Board voted in favor of the dues increase 6 votes to 0.

The treasurer wishes to thank Board members Mike Reynolds, Julius Benton, and Ken Poshedly, who are currently serving on the treasury committee. The committee requires independent Board members not holding a corporate office in the ALPO to perform detached oversight of ALPO financial operations. Current and future input from this committee will be welcomed as the ALPO grows and decisions independent from the treasurer will be needed.

The ALPO Endowment has, through the generous support of the ALPO membership, increased its value to $113,091.24 as of May 16, 2018. The Endowment size increased significantly through charitable bequests over the past year. The purpose of the ALPO Endowment is to provide funding for a future central office for the ALPO. The ALPO is currently fundraising for this fund. Organizing a business plan for such a headquarters would include a place to house and archive the ALPO's vast observational databases and literature, some of which date back to the 1940s. A central office with paid employees could take additional steps to preserve both electronic and hard copy data for future research projects. Such an office could curate and loan library materials and instrumentation to amateur astronomers in need. There are other possibilities, but having a physical presence would give the ALPO a sense of permanency that it does not have compared to our counterparts covering other aspects of amateur astronomy.

Matt Will suggested that with more charitable bequests coming into the Endowment, it might be time to reconsider stepping up income generation for the ALPO Endowment that could in turn be reinvested into the Endowment. In the past, when the Endowment was much smaller, the ALPO had a brokerage account where brokerage fees surpassed interest and dividends earned in the account. Since then, the Endowment has been directly invested in Certificates of Deposit at an FDIC bank that produces little growth from the interest generated from these CDs. Matt discussed some investing options where a small portion of the total Endowment could be directly invested in higher yielding financial instruments, thus improving income generation and reinvestment, though putting that portion of the fund at some risk.

ALPO member Jim Fox, who is a former Astronomical League President, recalled that the League enlisted the support of a brokerage to manage their assets when the interest rates at banks plummeted many years ago. Generally, the brokerages provide options for nonprofits to invest over a variety of investment instruments, generally directing the investing in a conservative strategy. Jim said that he could provide more information about the League's investing and would get back in touch with us.

Issue Three: General Membership Issues

(Introduced by Matt Will)

With the latest release of the ALPO Journal, the ALPO membership totals 337 members. Various ideas for improving membership numbers have been kicked around, discussed, and some have been implemented. Matt Will had assembled the ALPO Membership Workgroup some years ago to pool efforts among workgroup members in implementing strategies to promote ALPO membership. Matt had promised to kick off things with a membership survey, however, planning has been slow given the enormity of the task. It is hoped that the workgroup can be jump-started early next year when more time will be available for the membership secretary to complete this task. The last time a membership survey was conducted was 20 years ago, so one done now would provide an interesting perspective as much has changed in the way we communicate now.

Incidentally, one project that came to fruition out of the ALPO Membership Workgroup was the ALPO Podcast. The membership secretary that chaired the workgroup does not take any credit for this, but instead totally credits Tim Robertson's “self-starter” dedication for making this happen. Tim responded to Matt's remarks by stating that the podcasts would have never happened without participation from ALPO staff making themselves available for these interviews. Participation in the ALPO is key to making things happen

ALPO Lunar Meteoritics Impacts Program Coordinator Brian Cudnik during his presentation, “Prairie View Observatory ... What’s Up – or the Coming Pro-Am-Ed Experiences”.

Issue Four: Future Annual Meeting Venues

(Introduced by Richard Schmude)

Richard Schmude has informed the ALPO Board that the Astronomical League will not have a traditional ALCon in 2019 and instead will be hosting an ocean cruise on the anniversary of the Apollo 11 moon landing. Locations for future ALCons hosted by the Astronomical League member astronomical societies are uncertain. Under this backdrop, the ALPO Board entertained a broader discussion concerning future meeting sites for 2019 and beyond.

Next year, we are tentatively meeting with the Royal Astronomical Society of Canada, in Toronto, Ontario, Canada. Richard said that he still needs to confirm our invitation and to inform the RASC that we will be participating in their 2019 General Assembly meeting. The time of that meeting should be around the last week in June. Richard said that he would contact the RASC ahead of their 2018 General Assembly meeting to confirm our interest in meeting with them next year.

Discussion also focused on future annual meeting sites beyond 2019.

Some time ago, **PARI (Pisgah Astronomical Research Institute)** had extended a standing invitation to meet at their complex in western North Carolina. PARI could be a viable alternative if we want to meet on our own in the southeastern United States again. PARI is located near Brevard, North Carolina, about 50 miles south of Asheville. This area has limited local attractions, but it could be a good meeting site for the ALPO, meeting our needs for an annual meeting including some dorm-like accommodations and places for RVs. We could even have our own star party on the parking lot there if we wished.

SARA (Society of Amateur Radio Astronomers) has an annual conference that meets in June, usually at Green Bank Radio Observatory in West Virginia. Past discussions about the meeting with SARA included complications with the logistics for such a meeting. For example, as ALPO member Phil Plante pointed out, cell phone usage is not permitted in or near the Green Bank site for obvious reasons. Green Bank is also a rather remote meeting site, possibly less accommodating for our meeting needs, and thus requiring further planning for the ALPO. However, considering our limited meeting opportunities with other organizations, the annual meeting at Green Bank might still be a viable option after all. Something to ponder.

About 50 years ago, the ALPO had a joint meeting with the Southwest Region of the Astronomical League in Las Cruces, New Mexico. This was the only time that the ALPO actually met at a regional League conference. In current times, these regional League conferences can still rival the national ALCons themselves in manner of presentation, variety of speakers, interesting astronomical venues, and usually include a Saturday evening banquet. The Mid States Region and the North Central Region generally put on good meetings. Their meetings can occur any time between April through June. It isn't clear from the League's website if the other regions have regional meetings. The Astronomical League's Mid States Region and the North Central Region could be the best regions to meet with, having annual meetings in a similar manner that we are accustomed to. But these regional meetings may occur too early in the year for the ALPO. The Board deferred on making a final decision on future annual meeting sites beyond 2019 until sometime later.

Issue Five: Future Selection of Board Members

(Introduced by Ken Poshedly)

Ken Poshedly opened up discussion on this issue by commenting that the ALPO Board is getting older. Board members are all having to deal with various aliments of varying degrees. Ken stressed the need for younger, more energetic, and perhaps healthier Board members to replace our older Board members when either they feel that they no longer want to participate in Board activities or pass on. Ken thought there were some fine candidates in our list of section and program coordinators that could serve if asked or called upon.

Matt Will certainly agreed with Ken's comments. Matt made the personal observation that some of our Board members maintain busy observing sections, having to divide their time between their sections and ALPO administrative matters. This is especially true when a Board member assumes the role of executive director.

Currently, the ALPO is composed of seven board members and is expandable to nine in accordance with our by-laws. Matt thought that at least two Board seats should be reserved for Board members that exclusively perform administrative jobs such as journal editor and business-related functions as corporation secretary, membership secretary, and treasurer. The Journal is the ALPO's crown jewel and the complications involved in producing it in three-month cycles demand undivided attention and devotion. Also, the ALPO is a maturing nonprofit organization with expanding legal and financial responsibilities and persons with the time and expertise to delve into these matters should be put into at least one of these slots. We all want a Board that represents a broad cross-section of the ALPO, but we also want persons that can cover the ALPO's administrative functions and backside as well!

Matt suggested that a committee of Board members and staff be formed to vet future ALPO Board members from both inside the ALPO that represent the organization fairly and outside the ALPO for expertise on important matters that not may not be available from present members. Matt offered to come up with objectives for searching for such individuals and to co-chair this committee.

Issue Six: The Youth Section and General Membership Issues

(Introduced by Ken Poshedly)

Ken Poshedly expressed some concerns about the functionality of the ALPO Youth Section and current expectations with that section in promoting youth in the ALPO. Youth Section Coordinator Tim Robertson said that attempts had been made to work with the FOGE (Federation of Galaxy Explorers), a nonprofit organization that provides educational assistance to youth through space-based teaching programs. It was hoped that some cooperative venture would develop between FOGE and the ALPO Youth Section.

Tim stated that he had provided ALPO Training Program handbooks and other related materials but had not received any feedback from the FOGE concerning the use of these items. Tim also said that he has not had the time to devote an independent program for youth involvement in the ALPO, but would gladly welcome any help in that regard from anyone wanting to work on such matters.

Richard Schmude stated that one of his goals during his current tenure as ALPO Executive Director was to find a way to promote the use of ALPO observational data for youth-oriented science fair projects. Materials and suggested ideas for going about this could be posted on the

ALPO Executive Director with the Walter Haas Observer's Award plaque (left) for Marc Delcroix of France who could not attend, and with Tim Robertson winner of this year's Peggy Haas Service Award (right).

ALPO website. Given the orientation of youth with smart phones, Richard was interested in incorporating this into a cell phone app available from the ALPO website and was eager to work with someone that could produce such an app.

Along the same lines, Tim Robertson had asked about the status of the ALPO Twitter account. Tim thought that in order to reach younger people, that account should be more active and that he could help to manage it as an extension of the ALPO Podcast. Tim stated that he could work with Larry Owens and Steve Siedentop of the ALPO Online Section to make this happen.

Tim Robertson also wondered if there had been any movement with Explore Scientific in providing flyers about the ALPO with telescope purchases from this company. It had been agreed by the Board at last October's Board meeting that Scott Roberts, the CEO for Explore Scientific would be approached about providing this opportunity for the ALPO   Matt Will said that he would take the lead in producing a draft flyer for review to the ALPO Board for approval, before contacting Scott Roberts, in the near future.

Issue Seven: Observer's and Service Awards

(Introduced by Matt Will and Richard Schmude)

This year's recipient of the Walter H. Haas Observer's Award is ALPO member and observer Marc Delcroix of Tournefeuille, France. Marc has followed amateur astronomy from an early age during the era of the Pioneer and Voyager space probes. Marc became a serious planetary observer in 2006 using a 254mm Schmidt Cassegrain telescope and a webcam. He has since upgraded telescopes and imagers and has done spectacular work and is contributing images and observations to many of the ALPO observing sections.

Marc has also been involved in the management of the Commission of Planetary Observations of the Société Astronomique de France as a former president. Marc's pro-am experiences date back to 2007, when his images were used in the Cassini mission. Lately, professional astronomers have used Marc's imaging in conjunction with the detection of planetary impacts. Currently, Marc is carrying out imaging to detect bright regions on Neptune (first seen on amateur images in 2013) and the storms on Uranus (detected by amateur astronomers in 2014). Through it all, Marc has never lost touch with his initial excitement in the beauty and wonder of the universe when he started out as an amateur long ago. Congratulations Marc!

The Walter H. Haas Observer's Award recipient was selected from a committee that was composed of ALPO members; some are on staff and all are experienced observers that are familiar with the ALPO observing community. The committee chairman is grateful to those ALPO members that participated on the selection committee and submitted their votes in a timely manner. Matt Will chaired the selection committee in 2018. In agreement with the ALPO Board, Matt will seek out a replacement for the chairmanship later this year.

The Executive Director of the ALPO has sole discretion in the selection of a deserving awardee for the Peggy Haas Service Award, and can do so at any time of the year, and not necessarily every year, though annual meetings are more appropriate and auspicious for such a presentation. Our Executive Director Richard Schmude has selected Tim

Robertson for the honor of receiving this award. Tim has been an ALPO member for many years as an observer, and coordinator for the ALPO Training Program since 1993. Tim has been supportive of the ALPO in other respects but more recently has been involved with producing and hosting the ALPO podcast. ALPO podcasts have helped the ALPO reach new audiences of both novice and seasoned amateur astronomers world-wide over the internet and have generated a fresh interest in the ALPO with these groups. Tim's, heart, dedication, and passion breathes ALPO. Tim has been a hard worker for the organization both past and present and certainly deserves this honor.

Issue Eight: Staff Status

(Introduced by Mike Reynolds)

The accompanying table is a roster of our current acting staff.

Acting ALPO staff are eligible for permanent status, contingent on a vote of the Board.

The usual probationary period for review before the Board decides whether or not to grant permanent status is two years. The ALPO Board agreed to defer action on permanently appointing the two acting staff members in accordance with our usual rules.

Issue Nine: Scanning of Older ALPO Journals

(Introduced by Ken Poshedly)

Ken Poshedly mentioned that the scanning of pre-2001 issues of the Journal is proceeding smoothly. ALPO member Shawn Dilles has volunteered to scan these issues going all the way back to the ALPO's original founding publication date of March 1947. ALPO Board member, and former editor of the Journal, John Westfall, has agreed to lend and ship his personal copies of the Journal in installments, a few volumes at time, to Mr. Dilles for scanning. Shawn's care and dedication to this effort is evident in the meticulous manner in which he scans, documents, and reships the Journals back to John after scanning. Ken Poshedly is reviewing Shawn's work and with the help of the Online Section, Ken is uploading and organizing these scanned Journal files to the ALPO website as they become available.

The Board wishes to extend its heartfelt thanks to Shawn for taking on this enormous project that will certainly not only be valued by our present membership and the astronomical community, but also by amateur astronomers for generations to come!

Special thanks are also accorded to John, Larry Owens, coordinator of the Online Section, and Ken for starting and finishing off this process for all to enjoy.

Adjournment

Without any further new business to conduct, Richard Schmude made a motion to adjourn and John Westfall seconded. The motion passed with the Board members present voting unanimously in the affirmative with the Board meeting adjourning at 8:45 p.m. PDT on Friday, June 15, 2018.

Two Content Questions From John Westfall

(1) On p. 3 you say that an ALPO headquarters ".. would give the ALPO a sense of permanency that it does not have compared to our counterparts covering other aspects of amateur astronomy."

It would be interesting to conduct a survey of other amateur and amateur/professional astronomical organizations to see which of them actually have physical headquarters, how they are staffed, what they contain, etc.

(2) On p. 8 you discuss "Scanning of Older Journals", particularly about their being made available on the ALPO website. However, it's my understanding that they will be also supplied to the Astrophysics Data System (ADS) so they can be placed on their website and thus made available to the entire astronomical community.

Matt Will responds:

On point one, I have from time to time gone out to the websites of other astronomical organizations to learn as much as I can about their operations. You can learn a lot from reading the financial statements concerning sources of income (memberships, contributions to endowments, interest/dividends, grants, etc.) and expenses (literature, programs, outreach, insurance, staff payroll, building maintenance, etc.) When trying to open a dialogue with other astronomical organizations, I usually don't get any kind of response. Perhaps, it's not knowing the right person to contact or maybe they look at the ALPO as a competitor. I really don't know. The Astronomical League has been the most open in answering questions about operational mechanics. Recently, Bob Gent through Jim Fox explained their basic outline of investing for the League. Perhaps I can do a little more lurking on the websites, ask around more discretely, and report back to the Board at another time.

On point two, I do remember that this was brought up at a previous meeting that ADS was to receive scanned copies of issues of the Journal pre-1983 (Vol. 1 through Vol. 29), as they become available. I checked out the ADS website tonight and the same recently scanned copies, Vol. 27 through Vol 31, on our website are also residing on the ADS system. I know Ken is coordinating on this effort and can better answer questions John may still have about the process with ADS.

Acting ALPO Staff Appointments — 2018

Staff Member	Section	Title	Date of Appointment
Raffaello Lena	Lunar (Lunar Domes Survey)	Acting Coordinator	Feb 2015
Jim Phillips	Lunar (Lunar Domes Survey)	Acting Assistant Coordinator	Feb 2015

Papers & Presentations:

A Report on the 21 August 2017 Total Solar Eclipse – The Great American Eclipse

By Michael D. Reynolds, Coordinator, ALPO Eclipse Section
m.d.reynolds@fscj.edu

"As I repeatedly told my college astronomy classes: "You must see a total solar eclipse before you die!" It is true."

- Dick Hodgson

Introduction

The solar eclipse on 21 August 2017, better known as the "Great American Eclipse," was the first total solar eclipse to go over the Continental United States since the total solar eclipse of 26 February 1979 (see Figure 1). The path of totality, which began in the Pacific Ocean and ended in the Atlantic Ocean, went over fourteen states, from Oregon to South Carolina. The entire Continental United States observed a deep partial solar eclipse. The partial solar eclipse was visible on land from Northern Canada's Nunavut, northern South America, northwestern Europe and Africa, and Asia's Chukchi Peninsula.

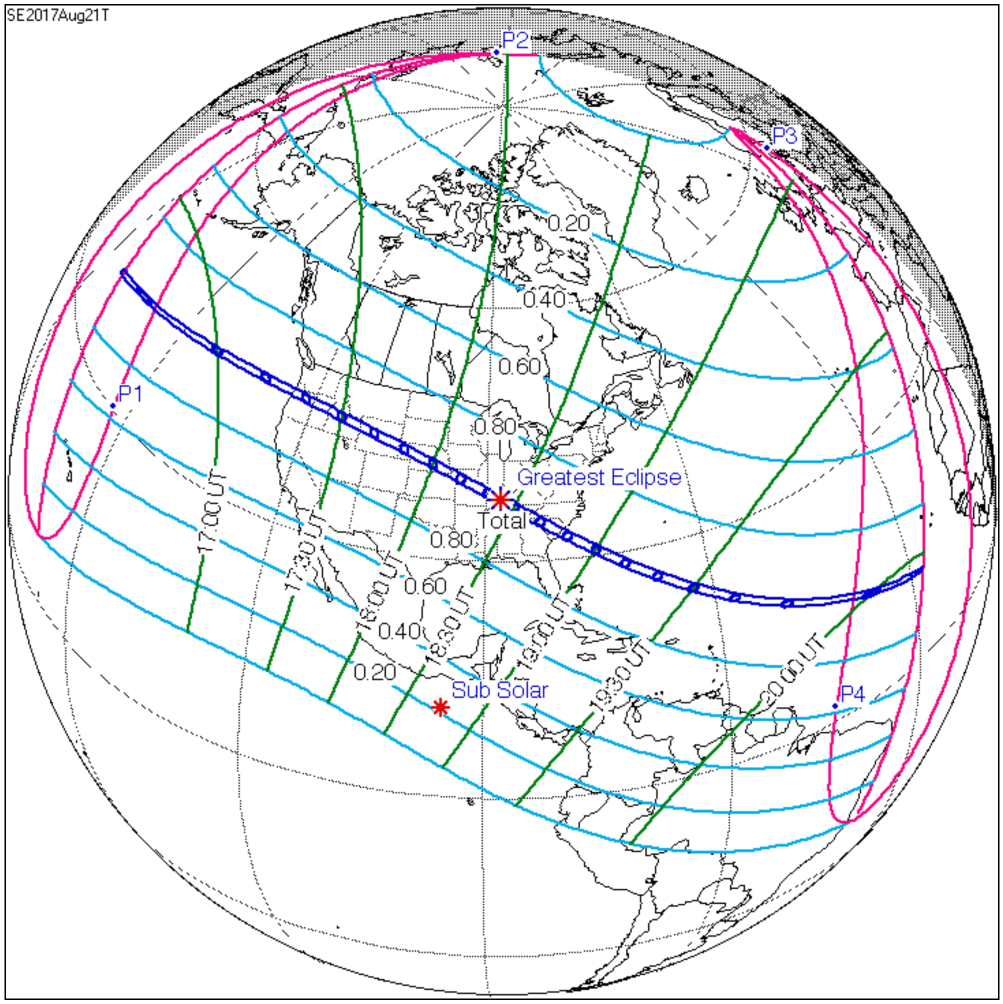


Figure 1. The path of the 21 August 2017 Solar Eclipse. Totality was visible in order from Oregon, Idaho, Montana, Wyoming, Nebraska, Kansas, Iowa, Missouri, Illinois, Kentucky, Tennessee, Georgia, North Carolina, and South Carolina. *Source: Fred Espenak, NASA Goddard Space Flight Center.*

For this member of Saros 145, the maximum length of totality was about 2 minutes 41 seconds and the maximum width of the Moon's shadow was about 115 kilometers. The magnitude of the eclipse — the fraction of the Moon's angular diameter to that of the Sun — was 1.0306.

It is estimated that around 50 million people traveled to the path of totality, making the Great American Eclipse perhaps one of the most-observed astronomical events in history. ALPO members also contributed numerous observations of both the partial and total phases. Some 79 reports were submitted, representing 91 observers. These reports of both the partial and total phases included a report of the event itself, imaging, sketches, and data such as weather. A matrix of the reports received can be found at the end of this report; Table 4, page 46.

Due to the length and volume of the ALPO submissions, this report will be an overview of reports and images, with all full reports received posted on the ALPO website, alpo-astronomy.com. It is also suspected that there ALPO members who did not submit a report, thus the number of ALPO observations most likely exceeds what is being presented here.

Some initial conclusions, based on ALPO reports and the eclipse overall:

- This was a true United States event, with many international observers and general public as well as amateur and professional astronomers.
- There were numerous organized events along the path of totality and in the partial eclipse, making the eclipse more enticing for many in the general public.
- Weather was good for most locations; excellent circumstances for observations and imaging.
- Equipment quality was at a high level, from telescopes to DSLR cameras and imaging devices.
- The one equipment issue was the availability of eclipse glasses; many communities ran out of eclipse glasses and there was a supposed issue with eclipse glasses purchased on a popular website.
- In some cases eclipse glasses that were normally being sold for $1 or $2 each were selling for $20 or more.
- Many hotels and campsites were booked years in advance of the eclipse; people had been planning for the eclipse.
- There were some traffic jams or slow traffic issues yet not as bad as some thought it could be; there were fears that eclipse day could look like a hurricane evacuation.

This report will overview:

- ALPO previous total solar eclipse experience
- An overview of submitted reports
- Types of data submitted
- ALPO eclipse imaging and drawings
- Other data

Table 1. ALPO Total Solar Eclipse Experience

Total Eclipse Experience; n = 74	Number, #	Percent,%
First Total Solar Eclipse	58	78.4%
2-5 Total Solar Eclipses	8	10.8%
6-10 Total Solar Eclipses	1	1.3%
>10 Total Solar Eclipses	7	9.5%

Figure 2. The thin crescent Sun through clouds prior to 2nd contact; Canon Zoom lens EF 75-300mm f/4-5.6 at 300 mm F/5.6 for 1/125 second, Canon EOS Rebel T3. *Source: Nancy Hogston and James Hyder, Troy KS.*

Table 2. Observations of Partial, Total, Clouds at Totality, 21 August 2017 Eclipse

Type	Number, #	Percent,%
Observed only the Partial Solar Eclipse	15	16.5%
Observed both Partial and Total	72	79.1%
Observed Partial, clouded out at Totality	4	4.4%

These report overviews are based on submitted reports. Full observer reports will be posted on the ALPO website; www.alpo-astronomy.com.

Previous Total Solar Eclipse Experiences

A follow-up email was sent to those submitting reports, which first acknowledged their submissions. The email also requested report clarifications as needed, as well some data on total solar eclipse experience including the number of total solar eclipses observed and clear versus totally cloudy skies at totality (see Table 1).

This data includes the 21 August 2017 solar eclipse.

Referring to the Table 1, over three-quarters of responding observers (58 out of 74) noted this was their first total solar eclipse, whereas less than 10% reported they had observed more than ten total solar eclipses, with the largest number of total solar eclipses observed was 19 total solar eclipses (Mike Reynolds).

Most observers reported clear or nearly clear skies at totality. Several of these observers noted observations through clouds (see Figure 2), yet reported, and in some cases imaged, seeing the second and third contacts as well as the corona. At St. Joseph, MO, Yvonne James noted that it rained 15 minutes before totality. As the shadow of the Moon approached, a hole appeared in the thicker clouds allowing those at St. Joseph Rosecrans Memorial Airport in St. Joseph, MO to see the diamond ring and corona.

Not all observers were so fortunate weather-wise, for four observers reported being clouded out at totality; 4.4% of reports received (see Table 2). These observers did report sky darkening as the Moon's shadow passed over, sunset effect, and/or hearing crickets or cicadas at totality.

Submitted Reports Overview

A number of observation types were submitted for the 21 August 2017 solar eclipse. Many of the submitted reports included more than one type of observation. Images and overall eclipse reports made up the vast majority of submissions. No edits were done on the following submitted report snippets.

- Observer's Name, location where the eclipse was viewed: comments gleaned from the report.

- Salvador Aguirre, Idaho Falls, ID: I noted naked eye prominences in three groups, a drop in the ambient temperature.

- Steve Bennett, Glendo State Park, WY: My visual impression of the corona during totality was of a “butterfly” shape, with the polar streamers evident as in the photograph.

- Barton Billard, Oak Knob, NC: During totality the corona was spectacular but it was not as dark as I expected, perhaps because of light scattered from the distant clouds.

- Geoff Chester, Smiths Ferry, ID: The temperature dropped about 20 degrees by the time totality arrived. Many of the attendees observed shadow bands on towels spread out on the river bank.

- Howard Cohen, Round Butte Overlook Park, OR: Many saw prominences that were visible in binoculars or even with the naked eye. We easily saw Venus, of course. More remarkable was Regulus. I could easily spot this star, only two Moon diameters down to the left of the Sun with binoculars.

- Carmel Cunningham, Indian Bluff Recreation Area, Lake Marion, SC: The weather was perfect, crowd was well-behaved, and it was a very spiritual event.

- Darryl Davis, W. Frankfort, IL: Most of my interest was focused on the surrounding condition of the environment. I saw the shadow coming from the west so fast that if I blinked it would be missed. At totality the air was cooler, birds began their “evening chirping,” and squirrels chattered. But after totality passed the environment resumed its normal patterns.

- Jack Eastman, Ft. Robinson State Park, NE: …a couple of nice prominences, beautiful coronal streamers. No shadow bands, I didn't see any stars, only Venus, blazing brightly to the west (right) of the Sun.

- Bill Flanagan, Ochoco National Forest, Mitchell, OR: We experienced about a 10°F temperature drop during totality. In addition to the beautiful corona, the camera managed to capture a bit of Earthshine on the moon and 3 stars, Regulus, Nu Leo, and 31 Leo.

- Andy Goshen, Leesville, SC: Corona was spectacular. Even with our bare eyes, it was still stunning, and from the slight rise on the center of the field we could see the 360 degree sunset and approaching shadow.

- Kalwant Grewal, Orangeburg, SC: Venus was clearly visible. Shadow was very noticeable, mesmerizing effect. Birds chirping, some crickets.

- Russell Grokett, Caspar, WY: Just before 2nd contact, the clouds disappeared, darkness fell fast, the temperature started falling and a light breeze came up. Coronal streamers were visible much larger than I imagined. Nearby horses bolted, but probably from our shouts as much as for the rapid “sunset”. Bats were seen flying overhead.

- Robert Hays, Jr., Arcadia, NE: The 2nd contact diamond ring and a few detached beads lingered for a seemingly long time. The corona was quite elongated east-west as seen with the naked eye. It was detected out to perhaps three lunar radii.

- Rik Hill, Caspar, WY: We got a good sequence with the 500mm lens in scattered light cirrus, if ingress partial phases and totality, and a couple images with the ETX in increasing cirrus. Egress partial phases were truncated by the clouds… We also had a flash spectrum camera using a transmission grating in front of the camera lens.

- Dick Hodgson, Troy, KS: During totality we were looking at the lunar disk through thin cloud... Perhaps what excited our first-timers to this event, as totality was about to end, was their running around the grounds looking at the “glorious sunrise” appearance of the horizon, all 360° of it!

- David Houlihan, Marion, IL: Just after totality ended, noted prominent shadow bands moving on the ground. Bands generally aligned northeast to southwest with movement towards the southeast at about 1 meter per second. Typically an individual band was 2-4 cm wide and 1 meter long. Entire area covered with shadow bands and the ground appeared to be crawling with shadows.

- Yvonne James, St. Joseph, MO: Two minutes before total darkness, the rain stopped, and right at the last second, a little “sucker-hole” opened up for us to see the diamond ring and totality. The clouds did not quite meet the horizon, and a beautiful 360 degree “sunset” was visible.

- Paul Jones, Columbia-Greenville Regional Airport, SC: I was amazed at how dark it got well before totality even began! It must have been around 45 minutes before totality that our surroundings began to get very eerie, dull, and muted as the moon slowly gobbled up more and more of the solar disk. Venus and Jupiter popped out, and the clouds around the horizon turned shades of burgundy and gold…

- Robert Little, Yulee, FL: 93% partial. The sky had a strange “sunset” feel to it but without the usual sunset colors. Another thing to note is that the chickens in the various pens were starting to roost, and the normally chatty birds were suddenly quiet.

- James Lyons, Pikeville, TN: Q500 Yuneec quadcopter using the onboard CGO2 HD camera and gimbal. Animal reactions- my friend with whom we were staying had his chickens go back to the coop and roost, one of the horses got loose and out of the corral due to being spooked. Frogs starting croaking just as if it was night and the same with crickets.

- Mike Mattei, Clarksville, TN: The sky was milky white with some blue, and some cirrus clouds, I did not notice any temperature change or see the twilight effect at the edge of the shadow.

- Clint McIntosh, Columbia, SC: The street lights and store signs started coming on - and it wasn't even at the darkest yet. I watched through my goggles as the sliver of light got smaller and smaller then it completely disappeared! I took off my goggles and I saw the most amazing sight I'd ever seen in my life. It was a full sensory experience in every direction.

- Stephen Miller, New Holland, SC: The morning started with dense, dense fog. Clouds cleared after 1st contact. Temperature went from 112.2°F to 88.1°F.

- Rod Paul, Columbia, SC: The light from the Sun dimmed and the temperature cooled. … we observed Baily's Beads, the Diamond Ring Effect, and the solar corona. The light during totality seemed similar to the light from a full moon. A group of ducks huddled together due to the darkness.

- Rob Pettengil, west of Torrington, WY: Our location on a hilltop had a great view of the north fork of the Platt river and the river valley towards Lingle, WY. Our location gave a nice view of the approaching and departing lunar shadow which I captured in 4k video from an iPhone. Unfortunately no shadow bands were visible in the valley.

- Jeff Pettitt, North of Cheyenne, WY: Using a mirror lens to take photos, images show an unidentified object photographed in the series of 13 total eclipse images.

- Phil Plante, Caspar, WY: It was perfectly clear until about half an hour before 2nd contact. Then, a few bands of high cirrus started to roll past the Sun. Had little effect on the eclipse. I could feel the temperature change and the wind picked up for a while but seemed to disappear during totality.

- Ken Poshedly, Murphy, NC: Tremendous and easy to observe pre-totality partial eclipsed miniature “Suns” projected by tree leaves.

- Theo Ramakers, Seneca, SC: An interesting clip was the final 2 seconds before totality, showing the elevations on the moon against the edge of the Sun (animated GIF).

- Michael Rosolina, Indian Boundary Campground, TN: We got the whole package with the light dimming noticeably as totality approached, the temperature dropping, crescent shaped shadows, crickets chirping, shadow snakes (shadow bands), and then the OMG moment itself. To sketch the eclipse, I prepared a template with 6 circles and recorded the appearance of the partial phases over a three hour time period using the 15x70's.

- Joe Salinas, Jr., San Antonio, TX: Set up telescopes for the public at the San Antonio College Scobee Education Center for the general public, with 4,000 visitors viewing the partial eclipse through my PST.

- Stephen Sands, DeSoto, MO: The sparkling diamond ring was mesmerizing. As the light danced through the craters on the limb of the moon, I stood motionless in awe and amazement of what I was witnessing. … As the diamond ring slipped away all too quickly, out popped the most magnificent corona and coronal streamers I could have ever imagined! A deer came out of the woods by the pond, obviously confused about what was occurring. Cicadas began serenading us with their high-pitched music. As the darkness increased prior to totality, Venus came into view west of the Sun. Mercury and Mars were a bit more difficult because of their apparent brightness and proximity to the Sun, but they made their brief appearances immediately before to immediately after totality. Further out to the southwest sat Jupiter which was not quite as bright as Venus. Sirius shined prominently in the southwest. Arcturus was to the east and Capella the northwest.

- Neal Scott, Lake Marion, Santee State Park, SC: The weather was ideal. I tried shooting video of shadow bands (no luck so far - need to enhance video further). I digitally recorded temp/humidity. I also boosted a VR camera (GoPro Omni) 20 feet high over a pier in Lake Marion. The video did a beautiful job of capturing the moon's shadow moving over distant clouds. It also captured the sound of hundreds of people reacting to the eclipse.

- Jim Selph, Mountain City, GA: The Eclipse was one of the most stunning and memorable events I have ever viewed in my life. I set the camera software up to do a series of bracketing shots and since this was my first eclipse I set the script for as many shots, ISO and exposures as I could cram into the two minutes I had.

- Pamela Shivak, Grace Chapel Campground, Smith's Ferry, ID: My personal observation of this, my first total solar eclipse, was that it did not get as dark as I had expected, more like an orange twilight and I was amazed how chilly it immediately got during Totality.

- Randy Shivak, Grace Chapel Campground, Smith's Ferry, ID: At mid eclipse the sky seemed to be that of 40 minutes after sunset.

- Keith Spring, The Farmhouse Inn, Tellico Plains, TN: Before totality the shadow was incredible. It was like an ocean of darkness washing over the land. The sunset colors were spectacular. I was only able to see 2/3 of the horizon but they were still amazing. I feel the reds were the most pronounced. I was able to see Mercury, Venus and quite a few stars. We saw lightning bugs, lots of little white fly bugs, and heard lots of crickets.

- John Sussenbach, north of Scottsbluff, NE: On Eclipse Day the morning started with dense morning fog, but around 10 o'clock the sky was completely clear. I had found a good observing site North of Scottsbluff close to the Central Line and from there I had a clear view in all directions. This was my seventh eclipse and the prospects were very favourable. After C1 the partial phase of the eclipse gradually progressed and close to C2 the storming dark Moon shadow could be well observed.

- Michael Sweetman, Tucson, AZ: My 1966 Tasco 7TE-5 f/16 60mm refractor got the call to service and performed wonderfully… Once set up, it took only ten seconds to have a sharp eclipse image on the sun projection screen.

- Randy Tatum, Madisonville, TN: Viewing conditions were clear to very slight cirrus. During the 2 min 36 sec totality the Sun was seen through a very thin cloud that did not affect the view. A moderate breeze from the West occurred during the partial phase before totality, but no wind was noticed at totality. I observed the flash spectrum, at 2nd contact. The color of the chromosphere and prominences were more subdued compared to eclipses in 1991 and 1979. I would call them silvery pink. A white sheet draped over south side of my car was used to observe and videotape the shadow bands. This was my forth total eclipse, but my first attempt to see the shadow bands. I observed bands visually for about 6 seconds between 10 sec to 16 sec after 3rd contact. They appeared to be moving towards the one o'clock direction.

- David Teske, Louisville, MS: A drawing was made before the eclipse, then a template was used to draw the position of the moon. … It was mostly clear, but cleared during mid-eclipse. Being Mississippi, it was HOT.

- Brad Timerson, Phelps, NY: I used my 10" Meade LX200GPS to track the Sun while taking images each minute through an Orion 80mm f/5 refractor with a solar filer and a Canon T3i. Observing conditions started out as clear, with some wind, and variable seeing conditions. Near mid-eclipse and until the end of the eclipse, more and more clouds interfered with viewing.

- David Tyler, Hodges, SC: Under clear skies we had a fabulous unforgettable view that no words can adequately describe. It's difficult to put soul into an image of such an event.

- Stephen A. Tzikas, Reston, VA (visual) and Green Bank, WV (radio): One of the various types of observations I made was in radio X-band frequency, using the 20m Skynet Dish in Green Bank, WV. The purpose of these observations is to illustrate power increase over a 3-minute period after maximum lunar coverage has passed.

- Christian Viladrich, Jackson Hole, WY: The optical tube in my Skywatcher Maksutov 127mm f/12 was insulated to reduce focus shift with temperature drop. Average seeing during the totality. No cloud, blue sky with some diffusion due to the presence of aerosols.

- John Westfall, Antioch, CA: The one observation I made was of the changing landscape brightness with a series of photos, all with the same lens, f/, ISO, exposure and color balance. (The camera was discouraged from any "helpful" efforts to change anything automatically.) I also used pinhole-mirror projection to cast a small solar image in the center of each photograph.

- Sam Whitby, Greenville, SC: At first the sky was completely clear. As totality neared, some big dark clouds threatened to interfere with our plans, but those clouds went another way. We had a wonderful view. We tried to photograph the shadow bands, but the photographs were very low contrast and were disappointing.

- Dennis Wilde, Tate Geological Museum, Casper, WY: About a half hour before totality we noticed the sky starting to dim in brightness. Clear until 15 minutes before totality. Light cirrus clouds developed in the vicinity of the Sun/Moon. It was eerie. 15 minutes before totality the sky had lost half of its original brightness, and was getting much cooler… 15 seconds before totality the sky got really dark…

- Matt Will, Marion, IL: A lunar peak could be seen touching the Sun's edge one minute before totality, on the northwest side of the limb where the moon approached. And then, Baily's beads could be seen on the southwestern portion of the Sun's limb, the last bit of the Sun's crescent, about a quarter of the Sun's circumference, was observed for about five seconds before totality.

- John Wright, Leslie, MO: Sudden ionization detection (SID) radio telescope. A solar eclipse should and does affect the SID signal. … data collected during the 21 August 2017 total solar eclipse did reveal a strong solar eclipse signal. NOTE: An article dedicated to Dr. Wright's research and results will appear in a future JALPO.

Table 3. Types of 21 August 2017 Eclipse Reports Submitted to the ALPO

Type	Number, #	Percent,%
Reports; general observations and comments	45	41.3%
Sketches	5	4.6%
Shadow, Shadow Bands, Sunset Effect	4	3.7%
Imaging; Still and Video	48	44.%
Weather	4	3.7%
Other; e.g. flash spectrum, radio astronomy	3	2.6%

Types of Data Submitted

Note that some observers submitted two or more types of observations; i.e. a written report and images. (See Table 3.)

ALPO Eclipse Imaging and Drawings

General Observations and Comments

A number of observers clearly noted location, weather conditions, and a description of the eclipse from their location. Reports also listed items such as observers in their group, a list and descriptions of equipment, and any issues.

Sketches

A few observers submitted sketches. Robert Hayes Jr., an active ALPO observer who has over many years submitted eclipse observations and reports, submitted some of his excellent drawings.

Shadow, Shadow Bands, Sunset Effects

A number of reports included descriptions of the Moon's shadow as it approached and covered observers. This included how dark the sky appeared as 2nd contact approached, planets and stars visible, and the appearance of the sky after 3rd contact.

Shadow bands were reported by a few observers. These can occur right before and at 2nd contact, at 3rd contact, and briefly after that event.

Reports also included descriptions of the sunset effect. This phenomena occurs when the Moon's shadow sweeps over a location; sunset colors appear at the horizon and usually all 360°. The appearance of the sunset effect varied from location to location, depending on the local topography and overall sky conditions

Imaging

With the large number of observers and today's high-quality equipment, numerous images of all aspects of the eclipse were taken. Well over 1,000 images were received by the ALPO Eclipse Section. The digital camera allows for so many functions that once properly focused, it can essentially act as an automated camera. Some observers process their images in a post-imaging software to clean up any issues. Some also stacked their images in order to produce an image that shows how the eclipse appears to the eye; this is called HDR (High Dynamic Range). Presented in this report is a very small representation of the many images taken.

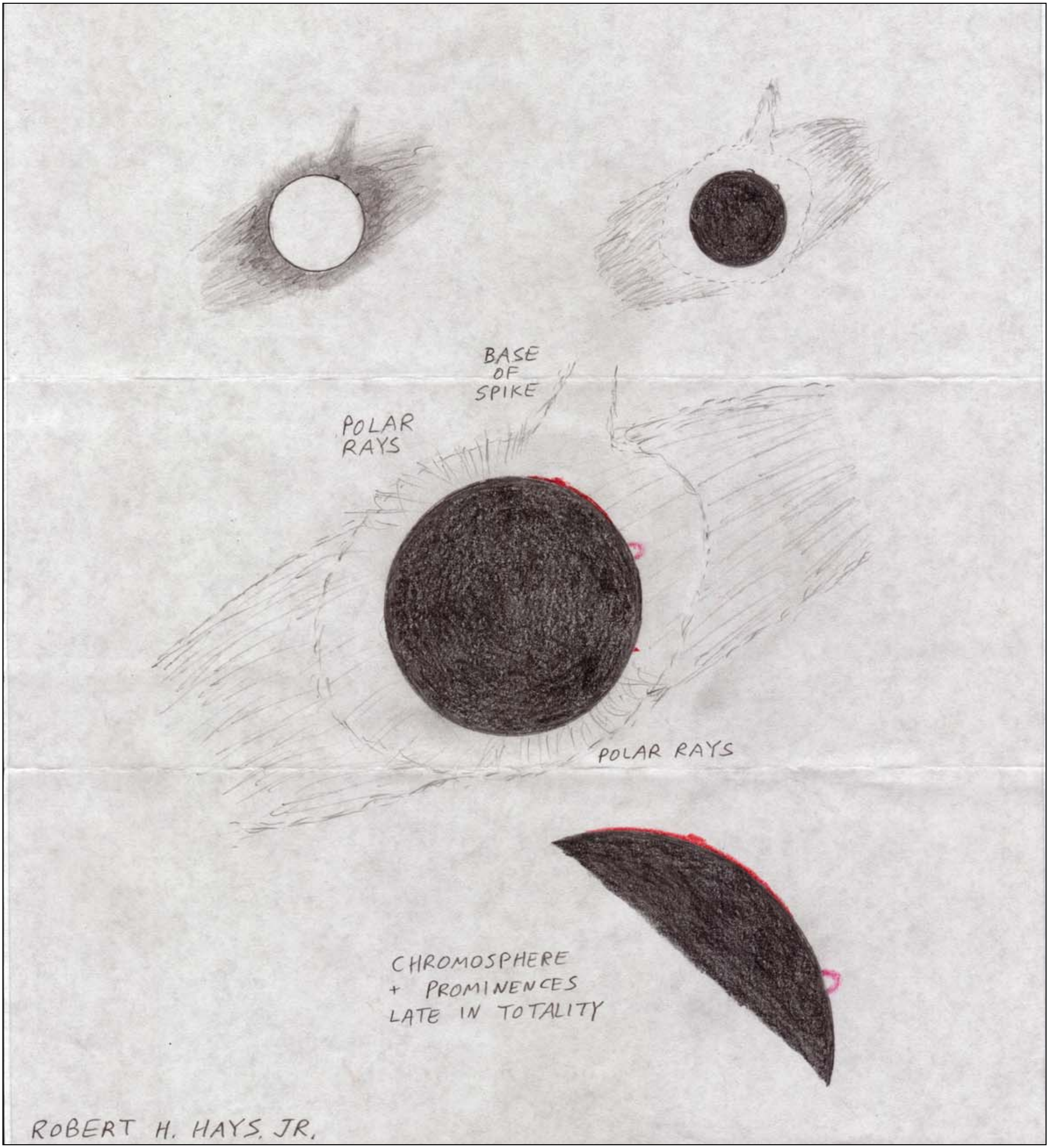


Figure 3. 2017 Solar Eclipse. Robert Hayes Jr., Arcadia, NE

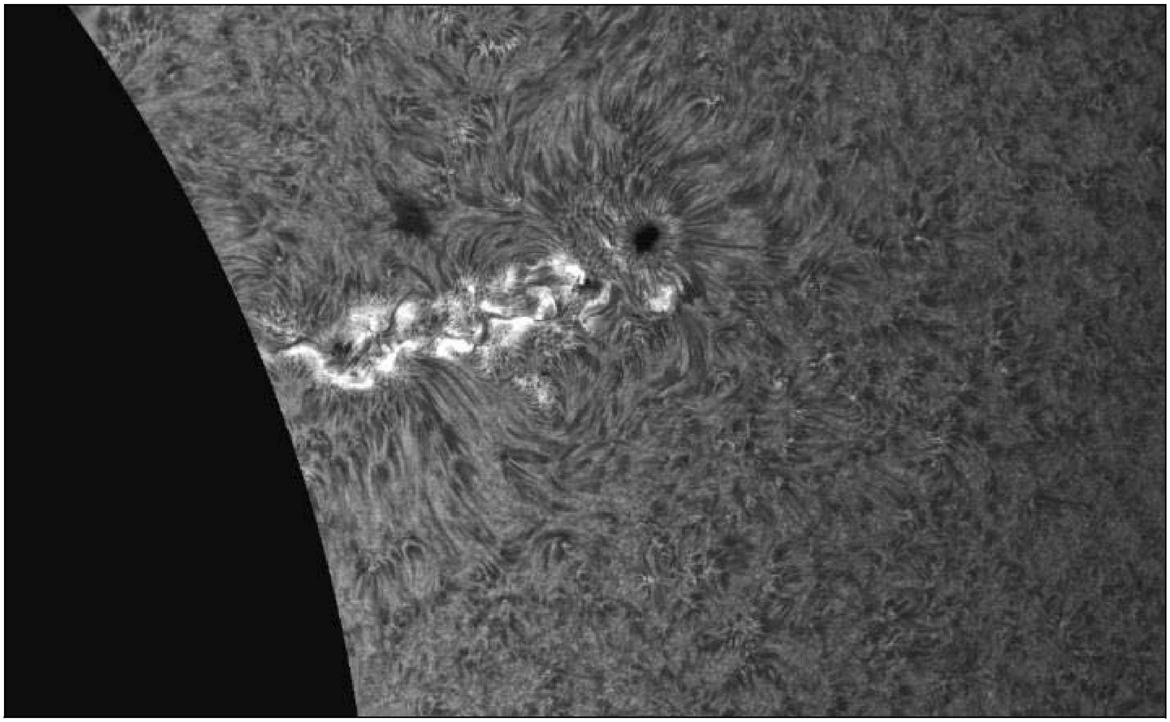


Figure 4. H-a Partial Eclipse; 152 mm f/8 Astro-Physics refractor, Daystar Quantum PE .5 angstrom H-alpha filter, ZWO ASI174mm video camera. 3,000 frames were taken and 300 were stacked to make the final image. Note also the edge of the Moon was slightly blocked via Photoshop to provide a smoother appearance. *Source: Randy Shivak, Smith's Ferry, ID*.

Figure 5. 2nd Contact - Diamond Ring; f/6.7, 75 mm refractor. *Source: Phil Plante, Casper, WY*.

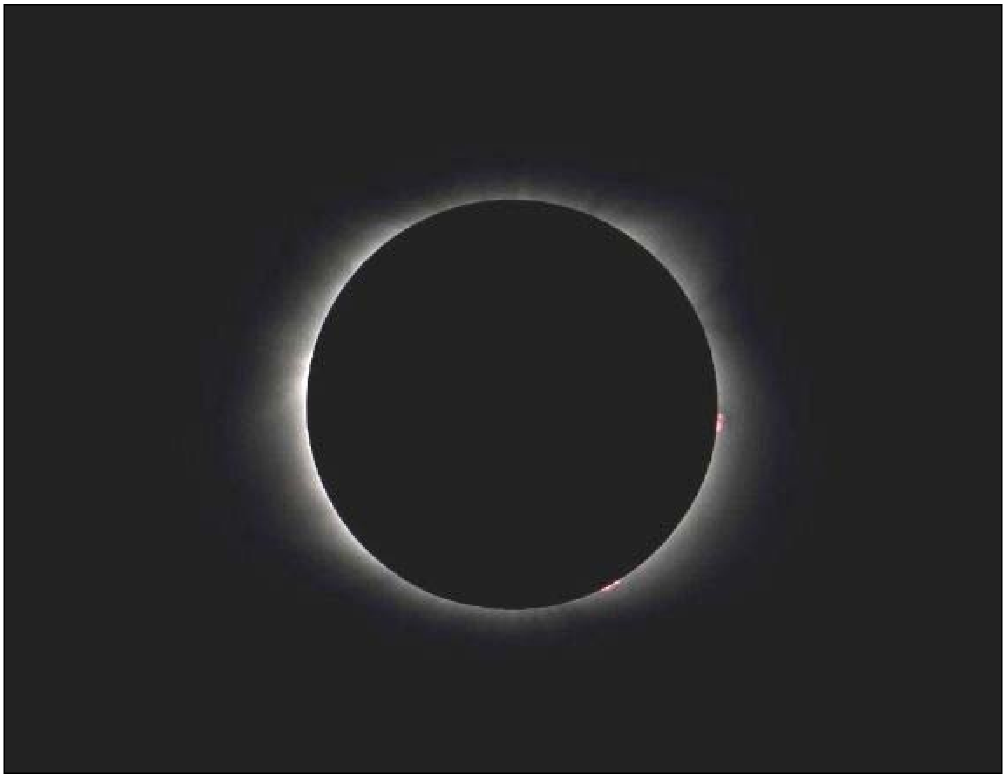


Figure 6. Totality - Inner Corona; 127 mm Explore Scientific APO, Canon 80D, 1/1250 second exposure. *Source: Keith Spring, Tellico Plains, TN*.

Figure 7. Totality sequence; 500 mm f/22, various exposures. *Source: Rik Hill, Casper, WY.*

Figure 8. Totality HDR Composite; note the Moon's features as well as the coronal structure; Canon 200 mm f/2.8L + 1.4x Extender, Canon 6D, Robert Nufer's software, SETnC v3.10 with laptop to control the camera and automate the exposure sequences. All exposures were made at ISO 100. During the total phase, two sequences of 10 shots each with shutter speeds ranging from 1/250 second to 4 second were acquired and merged to HDR with Photomatix Pro. *Source: Bill Flanagan, Ochoco National Forest, OR*.

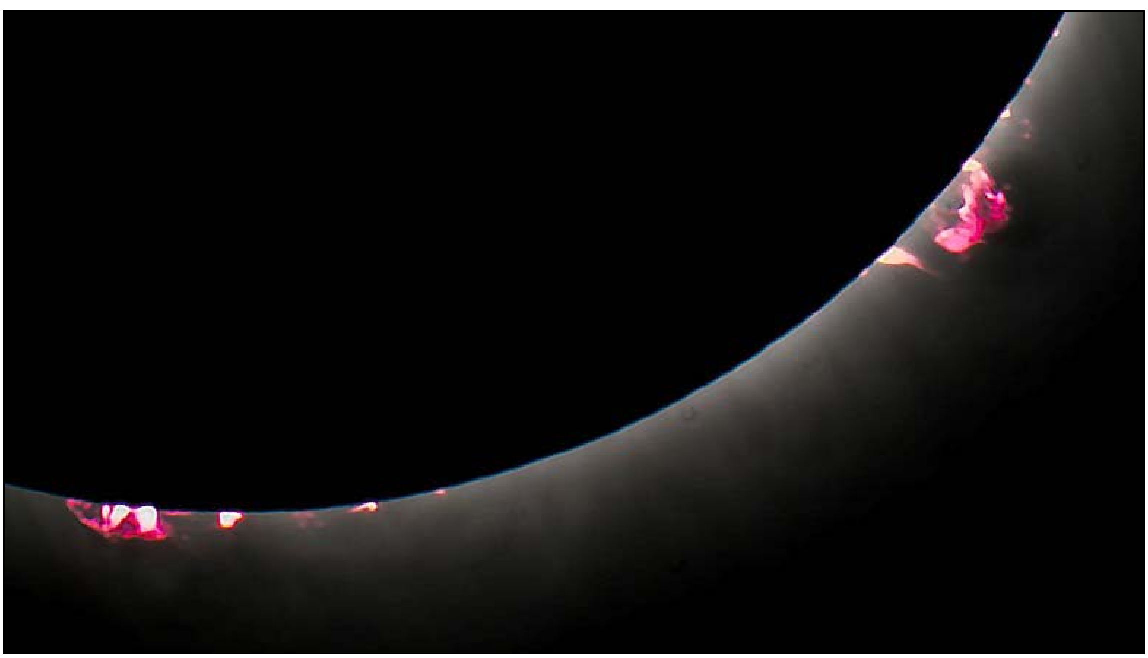


Figure 9. Prominences; and a 3.5 Questar f/16, Nikon D810, ¼ second exposure processed in Photoshop. *Source: Neal Scott, Lake Marion, Santee State Park, SC*.

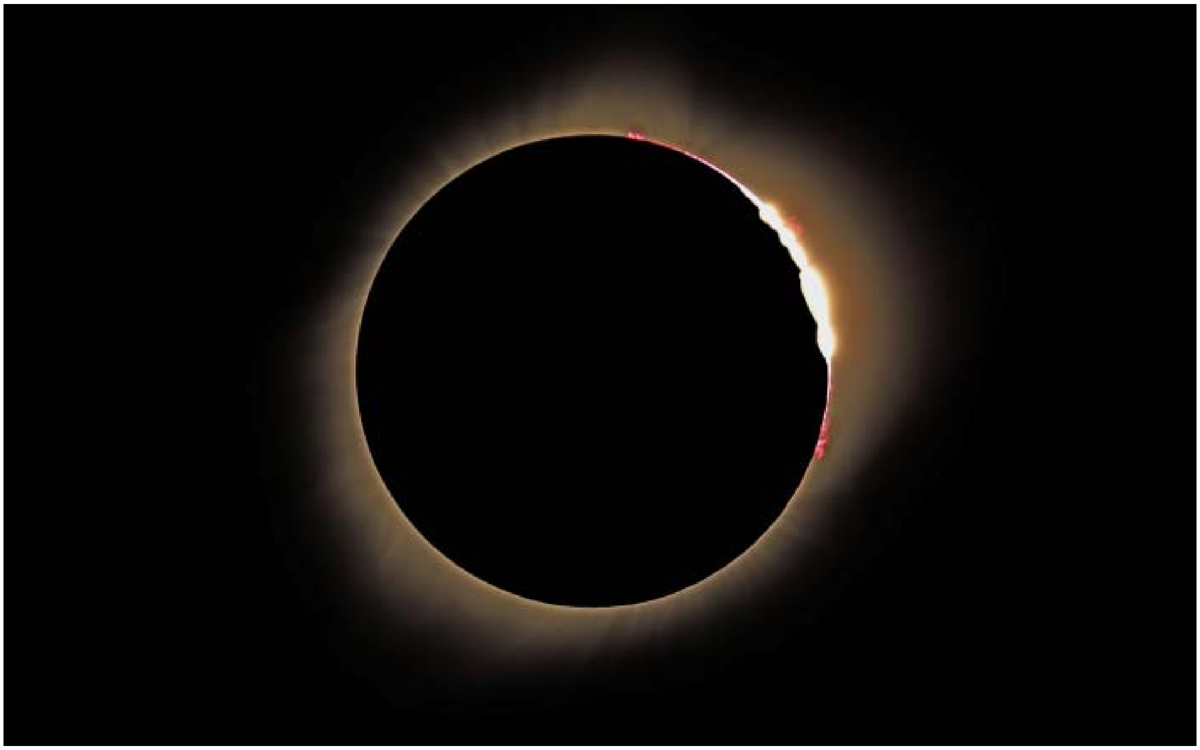


Figure 10. 3rd Contact and Baily's Beads; 3.5 Questar f/16, ISO 400 at 1/200 second. *Source: Mike Hood, Madras, OR*.

Figure 11. 3rd Contact Diamond Ring; 300 mm telephoto lens, Canon 60Da. *Source: John O'Neil, Smith's Ferry, ID*.

Miscellaneous Data

Weather

A few observers reported quantitative weather data, in particular temperature changes. One such observation is that of Vince Giovannone, from Latham, NY, where he observed the partial eclipse. Vince collected three types of temperature data: in direct sunlight, in shade, and blacktop. (See Figure 12.)

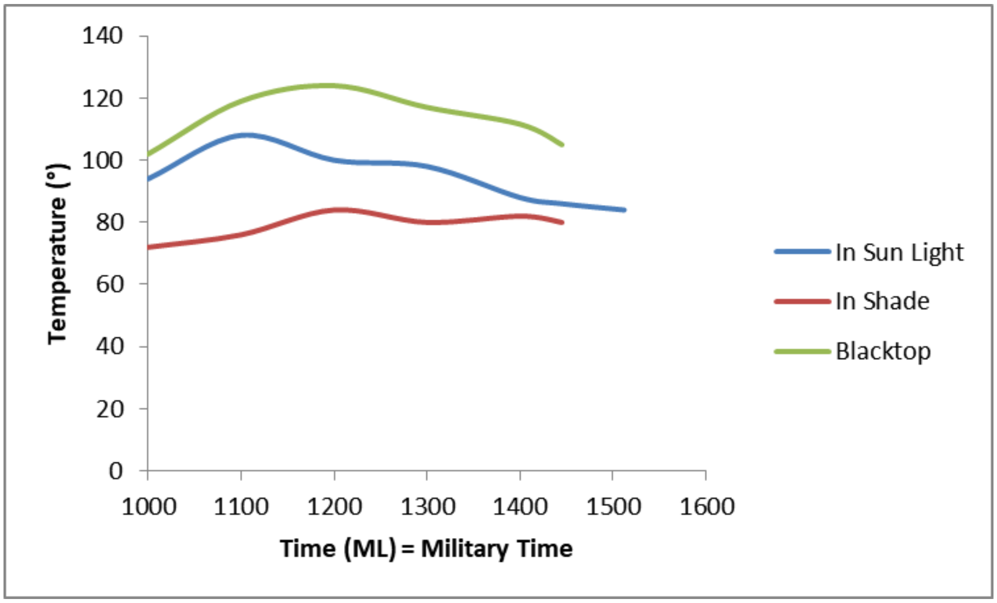


Figure 12. Temperature variations during the 21 August 2017 total solar eclipse.

Other Observations

Observers noted the activity of grasshoppers or cicadas during totality. In 18 previous total solar eclipses, I cannot remember this loud of volume due to totality-caused activity.

Many observers reported seeing other objects, including the 1st magnitude star Regulus, which was close to the totally-eclipsed Sun.

Randy Tatum recorded the flash spectrum at 2nd contact. The flash spectrum occurs as the Sun's bright photosphere is nearly covered by the Moon at 2nd contact, or as the Sun's photosphere is being uncovered at 3rd contact. The light is transitioning from photosphere to chromosphere. By using a prism or diffraction grating, one can image this rare phenomena. (See Figure 13.)

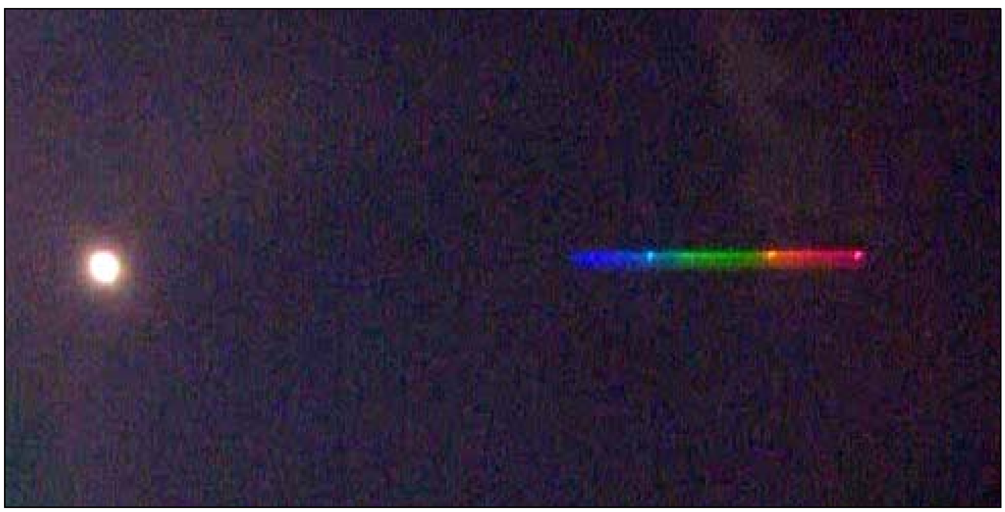


Figure 13. 2nd contact Flash Spectrum, using a Rainbow Symphony transmission grating (1,000 lines/mm). As the continuous spectrum faded, the emission lines appeared in the 1st order. The hydrogen-alpha line is the red spot to the far right. *Source: Randy Tatum, Madisonville, TN.*

Some observers reported seeing shadow bands, these fleeting, dark and light rapidly-moving bands across the ground or an object such as a sheet. Shadow bands are due to the refraction by Earth's atmospheric turbulence of the significantly-reduced Sun right before and after totality. Shadow bands are not seen at every total solar eclipse.

Looking Ahead: 8 April 2024

The Great North American Eclipse will see the Moon's shadow passing over Mexico, the United States, and Canada. The maximum duration of totality will be 4 minutes and 28 seconds, near the town of Nazas, Durango, Mexico. (See Figure 14.)

In Conclusion: Some of the Lessons Learned

Members of the Association of Lunar & Planetary Observers submitted numerous high-quality reports. The types of observations submitted varied as much as the interests and talents of the observers.

Many of the images contained in these submissions are of publication-quality. And with some post-imaging software work, many images can be brought up to publication quality. The only issue with some of the submitted images was focus. This cannot be corrected in post-imaging software.

For future eclipses - both solar and lunar - the ALPO might focus on one or two specific aspects of the eclipse to better collect data and submit reports to professional astronomers interested in such data. For example specific location and sizes of the solar corona at totality

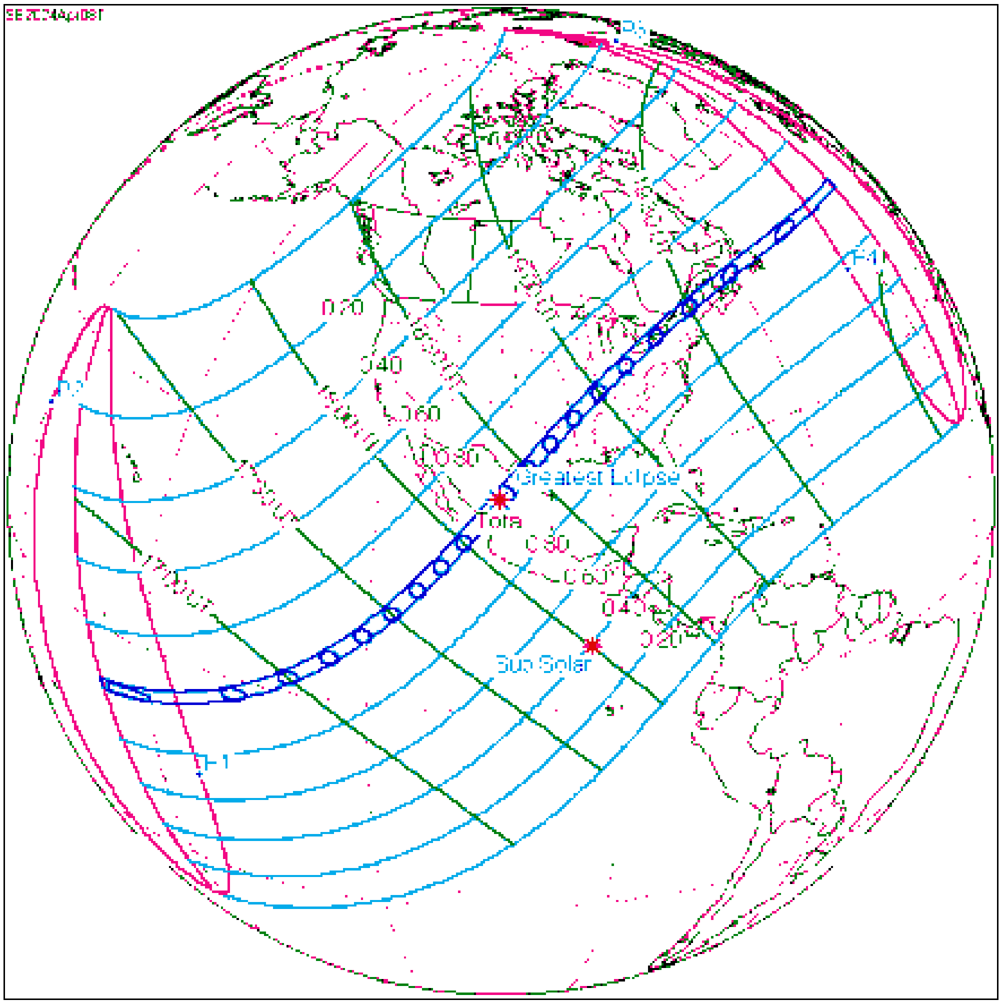


Figure 14. The path of the 8 April 2024 Solar Eclipse. Totality will be visible in order from Mexico, United States (Texas, Oklahoma, Arkansas, Missouri, Illinois, Kentucky, Indiana, Michigan, Ohio, Pennsylvania, New York, Vermont, New Hampshire, Maine), and Canada. *Source: Fred Espenak, NASA Goddard Space Flight Center.*

aids solar astronomers not only in studying the corona, but predicting coronal activity. Such a study and observations will take significant coordination since ALPO members have a variety of instruments and cameras - which is true in all of the amateur and professional world.

A number of important lessons for future eclipse observations came from the experience gleaned in ALPO observers' reports:

- One needs to pay close attention to advance preparation: lodging, equipment, test runs
- It can be challenging to produce data that allows imaging comparisons, like Citizen CATE
- Acquire your approved solar glasses in advance

For pre-eclipse talks and workshops:

- Specifics of the types of observations needed
- Report formats and information such as the observer's location; *I had no idea where I was; at some convenience store in Missouri…*
- Care with any camera or optical system being aimed at the Sun; there were numerous reports of camera sensor damage
- For imaging: focus, focus, focus!

I am very appreciative of all of the reports submitted. Any errors or omissions in this article is that of the author and not of the contributors. Please email any comments, corrections, and feedback to me at *m.d.reynolds@fscj.edu*

In Closing . . .

From "Corona and Coronet: Being a narrative of the Amherst Eclipse Expedition to Japan, in Mr. James's schooner-yacht Coronet, to observe the Sun's total obscuration 9th August, 1896" by Mabel Loomis Todd

"Then an instantaneous darkness leaped upon the world. Unearthly night enveloped all.

"With an indescribable out-flashing at the same instant the corona burst forth in mysterious radiance. But dimly seen through thin cloud, it was nevertheless beautiful beyond description, a celestial flame from some unimaginable heaven. Simultaneously the whole northwestern sky, nearly to the zenith, was flooded with lurid and startlingly brilliant orange, across which drifted clouds slightly darker, like flecks of liquid flame, or huge ejecta from some vast volcanic Hades. The west and southwest gleamed in shining lemon yellow.

"Least like a sunset, it was too somber and terrible. The pale, broken circle of coronal light still glowed on with thrilling peacefulness, while nature held her breath for another stage in this majestic spectacle."

Table 4. Contributors to This Report

No.	Name	Location	Eclipse (Partial / Total)		Type of Observation
1	Aguirre, Salvador	Idaho Falls, ID 43° 49' 48.5' N, 112° 02' 42.8" W		T	Imaging, Report
2	Albert, Jay	Casper, WY 42.855895° N,106.327514° W		T	Imaging, Sketch, Report
3	Antol, Bob	Poughquag, NY 41.613611° N, 73.671111° W	P		Imaging
4	Bennett, Steve	Glendo State Park, WY 42˚ 31’ N, 105˚ 0’ W		T	Imaging, Report
5	Billard, Barton	Oak Knob, NC 35° 19.0362' N, 83° 59.4840’ W		T	Imaging, Report
6	Borman, Mike	SE of Hopkinsville, KY 36° 48' 19.7" N, 87° 28' 59.24" W		T	Imaging
7	Chester, Geoff	Smiths Ferry, ID 44° 16.619' N, 116° 04.468' W		T	Imaging, Report
8	Cohen, Howard	Round Butte Overlook Park, OR 44° 36' 2.16" N, 121° 16' 26.61" W		T	Imaging, Report
9 10	Cunningham, Carmel and Joel	Indian Bluff Rec Area, Lake Marion, SC 33° 27' 14" N, 80° 09' 50" W		T	Imaging, Report
11	Davis, Darryl	W. Frankfort, IL 37° 53′ 55″ N, 88° 55′ 24″ W		T	Imaging, Report
12	Davis, Kendra Kleinik	W. Frankfort, IL 37° 53′ 55″ N, 88° 55′ 24″ W		T	Imaging
13	Desai, Aadil	Madisonville, TN 35° 33' 00.28" N, 84° 19' 03.81" W		T	Imaging
14	Eastman, Jack	N of Scottsbluff, NE 42.223660° N, 103.626755° W		T	Report, people pictures
15	Eskildsen, Howard	McMinnville, OR 45° 12′4 2″ N, 123° 11′ 50″ W		T	Imaging
16	Flanagan, Bill	Cougar East Trailhead, Ochoco National Forest, Mitchell, OR 44° 31' 31.5" N, 120° 22' 18.4" W		T	Imaging, Report
17	Garrett, Lawrence	Hopkinsville, KY 36° 52.158' N, 87° 30.693' W		T	Imaging, Report
18	Giovannone, Vince	Latham, NY 42° 40' N, 73° 45' W	P		Sketches, Weather
19	Gomez, Angel	Seneca, SC 34° 41′ 03″N, 82° 57′ 21″W		T	Imaging
20	Goshen, Andy	Leesville, SC 33° 55′ N, 81° 33′ W		T	Report

Table 4. Contributors to This Report (Continued)

No.	Name	Location	Eclipse (Partial / Total)		Type of Observation
21	Grewal, Kalwant	Orangeburg, SC 33° 29′ 49″ N, 80° 51′ 44″ W		T	Imaging, Report
22 23 24	Grokett, Russell and Jan Knight, Dan	Near Casper, WY 42.8251069° N, 106.3294919° W		T	Imaging, Report
25	Hays Jr., Robert	Arcadia, NE 41° 25′ 26″ N, 99° 7′ 29″ W		T	Sketches, Report
26 27	Hill, Rik and Dolores	Casper, WY 42.855895° N,106.327514° W		T	Imaging, Report
28 29 30	Hogston, Dick and Nancy Hyder, James	Troy, KS 39° 47′ 17″ N, 95° 5′ 27″ W		T	Imaging, Report
31	Hood, Mike	Madris, OR 44° 37′ 46.9“N121° 7' 9.8" W		T	Imaging
32	Houlihan, David	SE of Marion, IL 37.70° N, 88.90° W		T	Report
33	James, Yvonne	Rosecrans Airport, St. Joseph, MO 39° 46′ 19″ N, 94° 54′ 34.94″ W		T	Report, people pictures
34	Jones, Paul	Columbia Regional Airport, SC 33°56′20″N 081°07′10″W		T	Imaging, Report
35	Kaelin, Roy	W. Frankfort, IL 37° 53′ 55″ N, 88° 55′ 24″ W		T	Imaging
36	Lamm, Jim	Cadiz, KY 36° 52′ 04″N, 87° 49′ 03″ W		T	Report
37	Legrand, Michel	Ménez Hom, France (near Brest) 48° 13' 13" N, 04° 14' 02' W	P		Imaging
38	Little, Robert	Yulee, FL 30° 37′ 5 0″ N, 81° 34′ 26″ W	P		Imaging, Report
39	Lutes, Lauri Ann	Corvallis, OR 44° 34′ N, 123° 17′ W		T	Imaging
40	Lyons, James	Pikeville, TN 35° 36′ 27N″, 85° 11′ 29″ W		T	Imaging (drone), Report
41	Mangelsdorf, Tom	Wasilla, AK 61.58° N, 149.32° W	P		Imaging, Report
42	Mansbridge, Beth	Gainesville, FL 29° 39′ 7.19″ N, 82° 19′ 29.97″ W	P		Report
43	Mattei, Mike	N of Clarksville, TN 36° 42' 50" N, 87° 05' 51"		T	Imaging, Report

Table 4. Contributors to This Report (Continued)

No.	Name	Location	Eclipse (Partial / Total)		Type of Observation
44	McIntosh, Clint	Columbia, SC 34° 0′ 2″ N, 81° 2′ 5″ W		T	Report
45 46	Melillo, Frank and Jean	Atchison, KS 39° 33′ 45″ N, 95° 7′ 42″ W		T	Imaging, Report
47	Melka, Jim	Bloomsdale, MO 38° 0′ 57″ N, 90° 13′ 42″ W		T	Imaging
48	Miller, Stephen	New Holland, SC 33° 43.85' N, 81° 29.34' W		T	Imaging, Report
49	Nowak, Gary	Franklin, VT 44° 58′ 21″ N, 72° 53′ 19″ W	P		Report
50	O'Neal, John	Smith's Ferry ID 44° 18′ 05″ N, 116° 05′ 22″ W		T	Imaging
51	Parks, Julian	Rego Park, NY 40° 43′ 25″ N, 73° 51′ 36″ W	P		Imaging
52 53	Paul, Rod and Linda	Columbia, SC 34° 0′ 2″ N, 81° 2′ 5″ W		T	Imaging, Report
54	Pettengil, Rob	Just west of Torrington, WY 42° 6’ 26.92” N, 104° 17’ 5.88” W		T	Imaging, Report
55	Pettitt, Jeff	North of Cheyenne, WY 42.43043 N, 104.36078 W		T	Imaging, Report
56	Plante, Phil	Casper, WY 42° 51′ 0″ N, 106° 19′ 30″ W		T	Imaging, Report
57	Poshedly, Ken	Murphy, NC 35° 5′ 23″ N, 84° 1′ 48″ W			Partial eclipse/leaves image, Report
58	Rahn, Stephen	Douglas WY 42° 45′ 22″ N, 105° 23′ 4″ W		T	Imaging
59	Ramakers, Theo	Seneca, SC 34° 41′ 03″N, 82° 57′ 21″W		T	Imaging, Report
60 61	Reynolds, Mike and Debbie	Rosecrans Airport, St. Joseph, MO 39° 46′ 19″ N, 94° 54′ 34.94″ W		T	Report, shadow, sunset effect, people pictures
62	Rosolina, Michael	Indian Boundary Campground, Tellico Plains, TN 35.4014° N, 84.1061° W		T	Sketches, Report
63	Salinas Jr., Joe	Scobee Learning Center, San Antonio, TX 29.445162° N, 98.497728° W	P		Imaging, Report
64	Sands, Steve	DeSoto, MO 38° 08′ 26″ N, 90° 33′ 27″ W		T	Imaging, Report, people pictures
65	Scott, Neal	Lake Marion, Santee State Park, SC 33° 29′ N, 80° 29′ W		T	Report, Imaging, Weather data

Table 4. Contributors to This Report (Continued)

No.	Name	Location	Eclipse (Partial / Total)		Type of Observation
66	Selph, Jim	Mountain City, GA 34° 55' 16.13' N, 83° 22' 59.52" W		T	Imaging, Report
67	Shivak, Pamela	Smith's Ferry ID 44° 18′ 05″N, 116° 05′ 22″ W		T	Imaging, Report
68	Shivak, Randy	Smith's Ferry ID 44° 18′ 05″N, 116° 05′ 22″ W		T	Imaging, Report
69 70	Spring, Keith Rosenstiel-Spring, Sharon	Tellico Plains, TN 35.365137° N, 84.297481° W		T	Imaging, Report
71	Stahlhut, Susie	South Carolina State Museum, Columbia, SC 34° 0′ 2″ N, 81° 2′ 5″ W		T	Report
72	Sreenivasan, Suresh	Casper, WY 42.8251069° N, 106.3294919° W		T	Imaging
73	Sussenbach, John	Scottsbluff, NE 42° 08' 22.2″ N, 103° 40' 39.6″ W		T	Imaging, Report
74	Sweetman, Michael	Tucson, AZ 32° 13' 18″ N, 110° 55' 35″ W	P		Report
75	Tatum, Randy	Madisonville, TN 35° 33' 00.28" N, 84° 19' 03.81" W		T	Flash spectrum, visual, shadow bands
76	Teske, David	Louisville, MS 33° 7' 23" N, 89° 3' 22" W	P		Imaging, Sketches, Report
77	Timerson, Brad	Phelps, NY 43° 00' 24" N, 77° 07' 06" W	P		Imaging, Report
78	Tomney, Jim	Guernsey State Park, WY 42°17′24″ N, 104°45′50″ W		T	Imaging
79	Tyler, Dave	Hodges, SC 34° 17′ 13″ N, 82° 14′ 47″ W		T	Imaging, Report
80	Tzikas, Stephen	Green Bank, WV 38.4195° N, 79.8318° W Reston, VA 38.9072° N, 77.0369° W	P		Visual, Radio Astronomy, Report
81	Viladrich, Christian	Jackson Hole, WY 43° 35' 48.7" N, 110° 41' 54.9" W		T	Imaging
82 83	Westfall, John and Beth	Antioch, CA 38° 00' 18" N, 121° 48' 21" W	P		Imaging, Report
84 85	Whitby, Sam and Uta	Greenville, SC 34° 50′ 40″ N, 82° 23′ 8″ W		T	Report
86	Wilde, Dennis	Casper, WY 42.8251069° N, 106.3294919° W		T	Imaging, Report
87	Will, Matt	Marion, IL 37.7436° N, 88.9664° W		T	Imaging, Report

Table 4. Contributors to This Report (Continued)

No.	Name	Location	Eclipse (Partial / Total)		Type of Observation
88	Williams, Glenn	Nantahala National Forest, NC 35° 14′ 02″, 83° 33′ 33″ W		T	Imaging
89	Wilson, Tim	Jefferson City, MO 38° 34′ 36″ N, 91° 12′ 53 W″		T	Weather data
90	Wright, John	Leslie, MO 38° 25′ 04″ N, 91° 13′ 53″ W		T	Sudden Ionization Detection
91	Zincone, Ronald	Kingston, RI 41.480° N, 71.527° W	P		Imaging

Feature Story

Moon Phases – A Young Perspective

By Aesa Benton, soon-to-be ALPO member

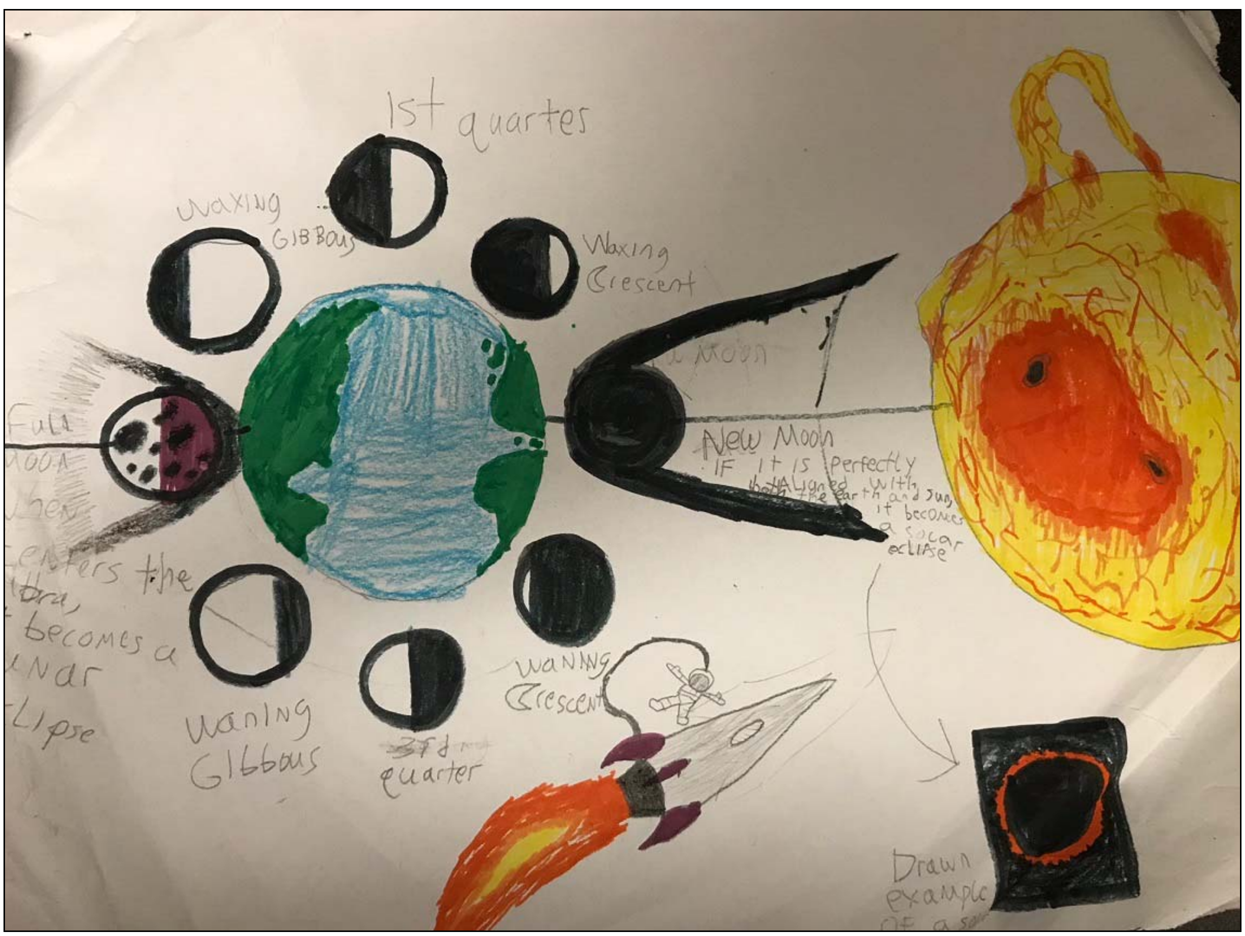
A couple of months ago in sixth grade, I did a project dealing with all eight phases of the Moon, considering that we were doing a unit on astronomy at the time. Because of my art skills, I decided to make it very detailed and artistic. Though I have bad handwriting, I chose to focus on the artful side of things. The good thing about astronomy is demonstrating things through visual art.

In my chart, I showed all eight phases of the Moon including both solar and lunar eclipses. My favorite part was the Sun because of how accurate it is. I added CMEs (coronal mass ejections), which are large solar rays that burst off of the Sun, along with sunspots, which are these small black spots that are colder areas on the Sun.

I think it is important for kids to learn about astronomy because there's more than we know out in space. We should try and discover more than just Earth, and human life itself. I hope to continue to express myself through artwork to show what I've learned.

About Asea Benton

Aesa Benton is 12 years old and was a rising 7th grader at Clarke Middle School in Athens, Georgia, when this article was written. He is the grandson of Julius Benton, the long-time coordinator of the Saturn and Venus Sections. Aesa has been interested in science, astronomy, and space-related topics since he was a very young age. It has been said that even as a six-month-old infant, he seemed to reach his small hand toward the sky on clear nights thinking he could touch the Moon. His "Moon Phases Project" was part of the 6th grade astronomy portion of the science curriculum at his school. Aesa loves science, especially astronomy and space, as well as expressing himself through his artistic talents. He loves to watch documentaries dealing with science and space. He has his own 80mm refracting telescope and likes to observe whenever possible and share his interests with friends and family.



Feature Story

Lunar Domes – The Marius Shield

By Raffaello Lena, Acting Coordinator, ALPO Lunar Domes Program,
raffaello.lena@alpo-astronomy.org
Jim Phillips, Acting Assistant Coordinator, ALPO Lunar Domes Program,
thefamily90@gmail.com

Online Readers

Your comments, questions, submitting observing reports of your own, etc., about this report are appreciated. Please send them to the authors by left-clicking your mouse on either of the e-mail addresses under the bylines on this page in blue text.

Also left-click on any hyperlinks in blue text within the text of this paper for additional information.

Observing Scales

Standard ALPO Scale of Intensity:
0.0 = Completely black
10.0 = Very brightest features
Intermediate values are assigned along the scale to account for observed intensity of features

ALPO Scale of Seeing Conditions:
0 = Worst
• 10 = Perfect

IAU directions are used in all instances.

Abstract

In this article, we examine the Marius Hills region. All domes belong to the wide Marius shield first introduced by Spudis et al. [2013] and a classification of these volcanic edifices is given: during our survey we have characterized a total of 41 features (40 domes and one lunar cone). Finally, using new data acquired, we have updated our maps which illustrate the distribution of some lunar domes in the Marius shield.

Introduction

The Marius Hills region in the Oceanus Procellarum consists of large numbers of lunar domes which formed as a result of multiple volcanic outbreaks. A general overview of the region and a composite drawing of the Marius Hills has been presented and discussed by Phillips [1990]. In the book “Lunar Domes properties and formation processes”, 30 of these domes, termed Ma1-Ma30, are described with tables giving various properties of each of these domes [Lena et al., 2013]. A further dome, Ma31, has been measured during our survey carried out in the Marius Hills, where low domes can be found as well as steep-sided features with rough surfaces resulting from superposed flow lobes and cones and often, steep domes which are superimposed on low domes [Lena, 2015; Lena et al., 2009].

Marius Hills presumably consist of several superimposed volcanic constructs which originated during several effusive phases (figures 1 through 3). The visible sinuous rilles in the Marius Hills region indicate they were the source of fluid lavas of basaltic composition. However spectral studies indicate that some of the volcanic constructs are coated with volcanic ash, suggesting that they resulted from explosive eruptions and demonstrating that complex volcanic activity occurred in several volcanic phases in this region [McBride et al., 2018]. The region of the Marius Group is identified as a volcanic shield by Spudis et al. [2013] and occurs on an elongated, elliptical topographic rise approximately 330 km in extent and rises about 2.2 km above the surrounding mare plain.

The following is a continuation of this characterization of domes in the Marius shield region as an ALPO project. All ALPO members are encouraged to participate in this project with their own observations. For the current study, we have analyzed 16 CCD images reported in Table 1. Based on CCD telescopic images and GLD 100 dataset [Scholten et al., 2012], we describe the morphometric properties of further 10 volcanic constructs (nine lunar domes and one lunar cone), thus extending their classification as proposed by Lena et al. [Lena et al., 2013; Lena et al., 2009].

Table 1. Observers and number of the analyzed CCD images.

Observers	Images	Telescope
R. Benavides (Spain)	1	Schmidt Cassegrain 28 cm
R. Lena (Italy)	3	Mak Cassegrain 18 cm
J. Phillips (USA)	9	TMB 20 cm refractor
M. Wirths (USA)	3	Dobsonian 40 cm

Data Sources and Approach

The new global topographic map of the Moon obtained by the Lunar Reconnaissance Orbiter (LRO) is the principal source of topographic information used in this study. Associated topographic profiles of each feature examined were extracted from the GLD100 database using the Quickmap LRO global basemap (http://

target.lroc.asu.edu/da/qmap.html). We have used the basic classification and mapping introduced in previous studies by GLR group [Lena et al., 2013], including the distinction between effusive domes and intrusive domes, based on physical modeling. These models have been routinely used for estimating the rheologic properties and dike geometries for a large number of monogenetic lunar mare domes in previous studies [Lena et al., 2013; Wöhler, Lena, Phillips, 2007; Wöhler et al., 2006], where more detailed explanations can be found. These parameters are closely related to the physical and compositional properties of the erupted magma.

Morphometric data and 3D reconstruction have also been obtained from CCD telescopic images using photoclinometry and shape-from-shading techniques (SfS) [Lena et al., 2013]. Generating an elevation map of a part of the lunar surface requires its three-dimensional (3D) reconstruction. SfS is a well-known image-based method for 3D surface reconstruction. It makes use of the fact that surface parts inclined towards the light source appear brighter than surface parts inclined away from it. This method takes into account the geometric configuration of camera, light

Lunar Dome Classification System

Effusive Domes

Class A domes are small and shallow and formed by high-TiO_2 lavas of low viscosity, erupting at high effusion rates over very short periods of time, resulting in edifices of low volume.

Class B domes consist of lavas of intermediate to high viscosity and moderate TiO_2 content, erupting at low to intermediate effusion rates. If the effusion process continues over a long period of time, steep flank slopes and high volumes may occur (class B_1), while short periods of effusion result in shallower edifices of lower volume (class B_2).

Class C domes are formed out of low-TiO_2 (class C_1) or high-TiO_2 (class C_2) lavas building up edifices of large diameter but shallow flank slope. These at shapes are due to low lava viscosities and high effusion rates.

Class E domes represent the smallest volcanic edifices formed by effusive mechanisms (diameter < 6 km). In analogy to class B, the class E domes are subdivided into subclasses E_1 and E_2, denoting the steep-sided flank slope larger than 2° and the shallow edifices of this class, respectively.

Class D comprises the very complex, shallow but large and voluminous edifices Arago α and ß, which were most probably formed during several subsequent effusion stages, while classes A-E describe simple, likely monogenetic effusive domes.

Class G comprises the highland domes, which have highland-like spectral signatures and high flank slopes of 5°–15°, represented by Gruithuisen and Maairan highland domes.

Class H is represented by the non-monogenetic Marius domes, subdivided into three different classes. Small domes of less than 5 km diameter belong to subclass H_1. The irregular shapes of domes of subclass H_2 with more than 5 km diameter and flank slopes below 5° indicate a formation during several effusive episodes. Domes of subclass H_3 have diameters comparable to those of monogenetic class B_1 domes, but their flank slopes are all steeper than 5° and reach values of up to 9°.

Putative Intrusive Domes

Lunar domes with very low flank slopes differ considerably from the more typical lunar effusive domes. Some of these domes are exceptionally large, and many of them are associated with faults or linear rilles of presumably tensional origin, while they do not show summit pits. A reliable discriminative criterion is the circularity of the dome outline: these domes are elongated and with low slopes (< 0.9°). The putative intrusive domes have circularity values below 0.8, while the circularity is always higher than 0.9 for the effusive domes having flank slopes below 0.9° and displaying effusive vents.

Class In1 comprises large domes with diameters above 25 km and flank slopes of 0.2°–0.6° and have linear o curvilinear rilles traversing the summit.

Class In2 is made up by smaller and slightly steeper domes with diameters of 10-15 km and flank slopes between 0.4° and 0.9°.

Class In3 comprises low domes with diameters of 13-20 km and flank slopes below 0.3°.

source, and the surface normal, as well as the reflectance properties of the surface to be reconstructed [Horn, 1989].

Spectral analyses are released on the calibrated and normalized Clementine UVVIS and NIR reflectance data [Eliason et al., 1999]. The five UVVIS (415, 750, 900, 950, and 1000 nm) and four NIR wavelengths (1100, 1250, 1500, 2000 nm) are available at the PDS Map-a-Planet site (*http://www.mapaplanet.org/explorer/moon.html*). In this work, data from the M^3 instruments were used to derive spectral data that highlight mineralogical characteristics of lunar volcanic materials including volcanic glasses signature. Chandrayaan-1's *Moon Mineralogy Mapper* (M^3) is an imaging reflectance spectrometer that can detect 85 channels between 460 to 3,000 nm, and has a spatial resolution of 140 and 280 meter per pixel [Isaacson et al., 2011]. Data have been obtained through the M^3 calibration pipeline to produce reflectance with photometric and geometric corrections using image sets taken during the optical period OP2C1.

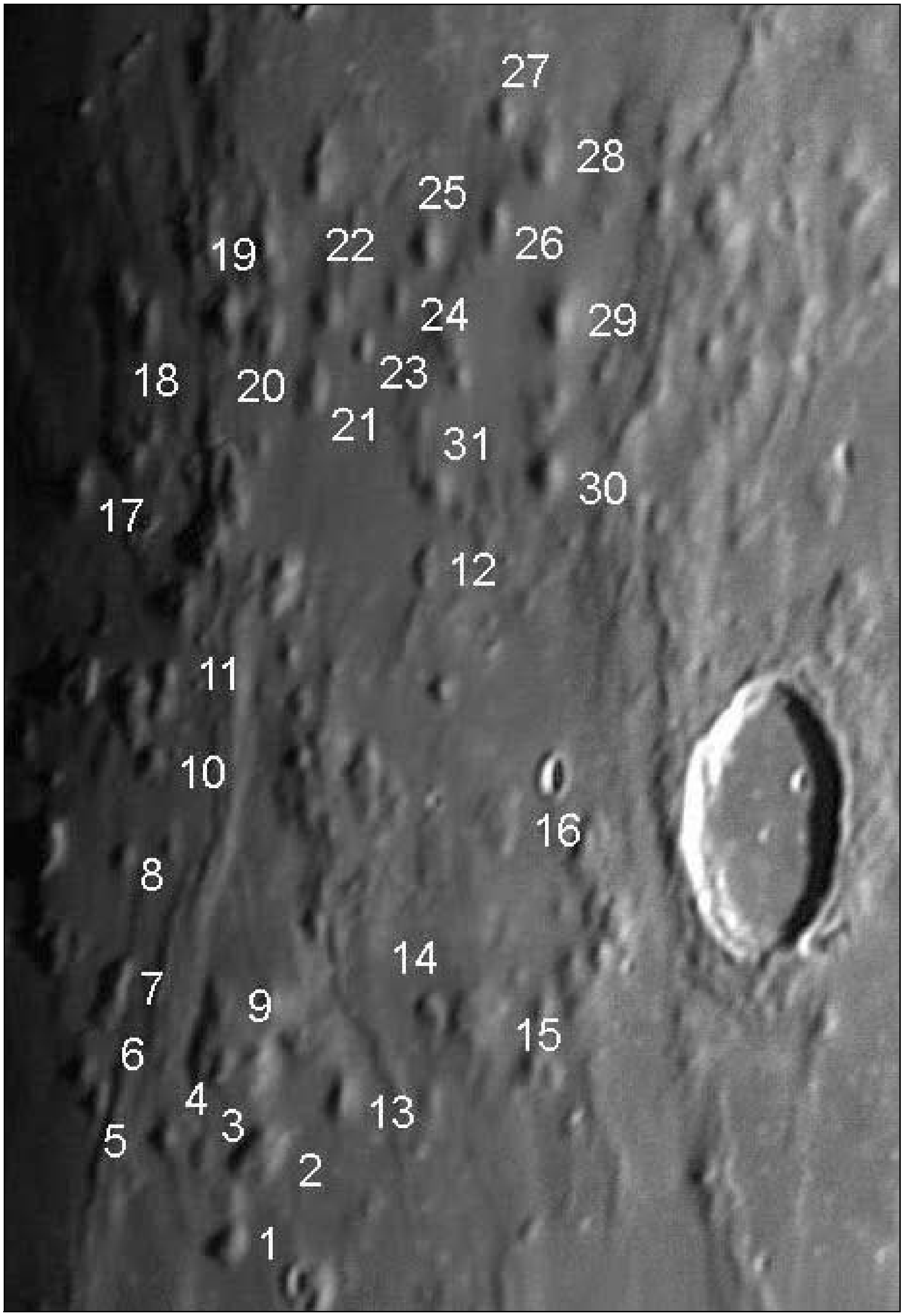


Figure 1: Telescopic CCD image of the Marius Hills region, acquired under oblique illumination on April 18, 2008, at 02:08 UT by Jim Phillips using a TMB 20 cm refractor. The analyzed domes are labeled as Ma1-Ma31 (Table 2).

For deriving the spectral parameters, the photometrically corrected Level 2 data of the PDS imaging node have been used [Isaacson et al., 2011]. The calibration of M^3 data is presented in detail by Green et al. [2011]. These spectra are not thermally corrected, so we do not analyze wavelengths longer than 2,600 nm, as these have a significant thermal emission component. This does not diminish the efficacy of our analysis because the relevant spectral features are located below 2,500 nm. In order to characterize the 1,000 nm band, we use a continuum removal method that enhances the characteristic of the 1,000 nm absorption band and more accurately shows the position of the band center.

Ground-Based Observations

Some telescopic CCD images of the lunar region examined are shown in figures 1 through 3. The images were taken under different solar illumination angle by Phillips, Lena, Benavides and Wirths. Some domes have been measured in our previous studies (Table 2), while the examined domes described in this paper are reported in Table 3, and marked in the WAC imagery shown in Figure 4. Using the *Lunar Terminator*

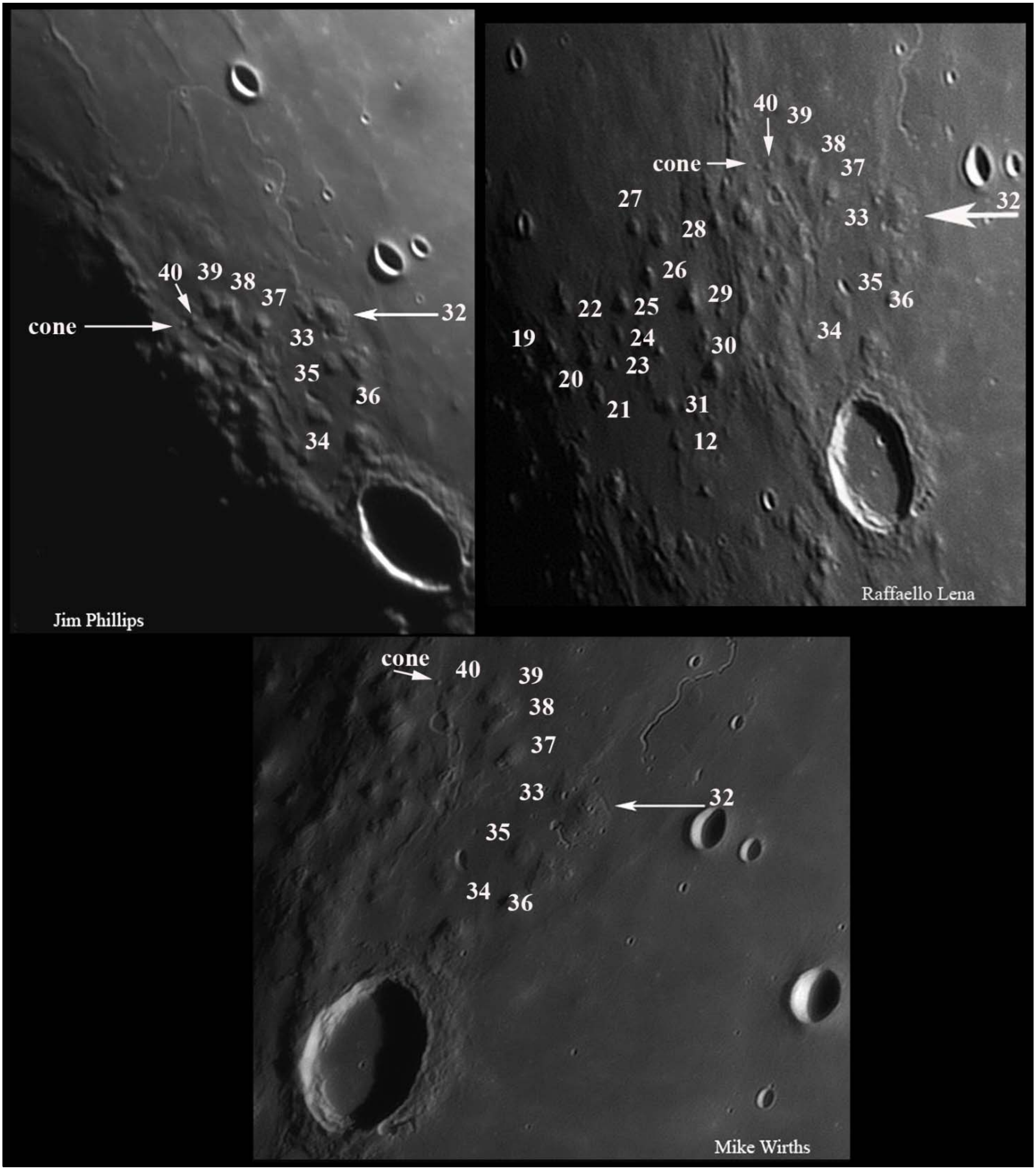


Figure 2. Marius region. Top left: Jim Phillips January 13, 2014 TMB 20 cm refractor. Top right: Raffaello Lena April 8, 2017 22:53 UT Mak Cassegrain 18 cm. Bottom: Mike Wirths image taken using a Starmaster driven Dobsonian 40 cm.

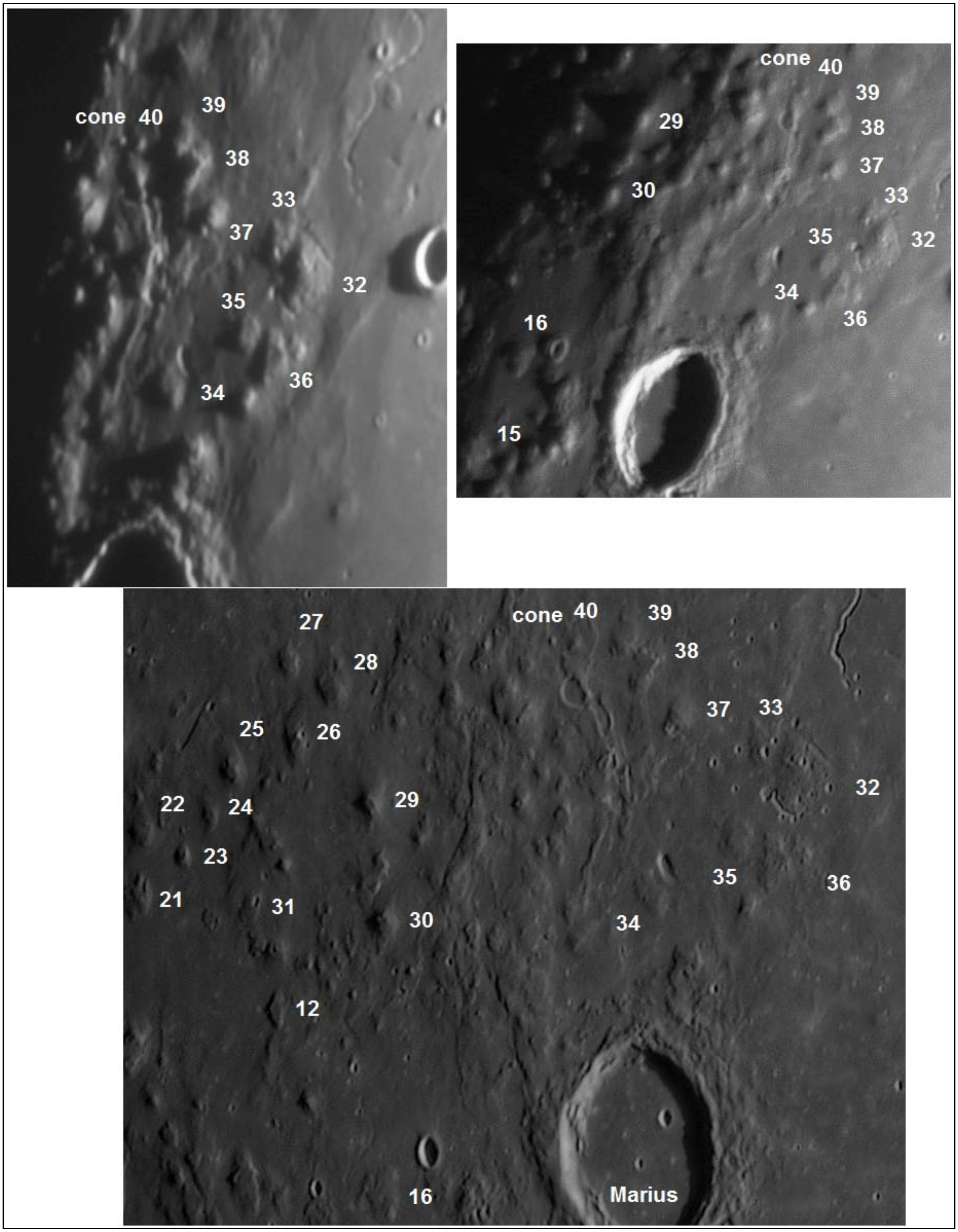


Figure 3. Marius region. Top left: Jim Phillips November 4, 2014 TMB 20 cm refractor, image taken under strongly oblique solar illumination angle. Top right: Rafael Benavides January 9, 2017 21:18 UT Schmidt Cassegrain 28 cm. Bottom: Mike Wirths crop of a large mosaic using a Starmaster driven Dobsonian 40 cm. Note the quality of the image and the details detected on the summit of several domes.

Table 2. Morphometric properties of the domes previously measured in our previous studies [Lena et al., 2013]. (NOTE: Some data regarding coordinates and heights have been updated during the survey and the current study.)

Dome	Longitude	Latitude	Slope [°]	Diameter [km]	Height [m]	Class
Ma1	-55.53	9.88	5.70±0.5	7.8±0.5	390±40	H_3
Ma2	-55.26	10.32	5.50±0.5	12.1±0.5	580±60	H_2
Ma3	-55.81	10.32	2.10±0.2	6.4±0.5	120±15	H_2
Ma4	-56.15	10.72	3.90±0.4	6.1±0.5	210±20	H_2
Ma5	-55.96	10.72	3.50±0.4	5.9±0.5	180±20	H_1
Ma6	-56.83	10.58	3.40±0.3	6.1±0.5	180±20	H_2
Ma7	-56.67	11.10	2.90±0.3	9.2±0.5	230±20	H_2
Ma8	-56.61	11.74	3.80±0.4	6.4±0.5	210±20	H_2
Ma9	-55.68	11.04	2.80±0.3	8.1±0.5	200±20	H_2
Ma10	-56.37	12.19	4.30±0.4	7.5±0.5	280±30	H_2
Ma11	-56.60	12.49	4.10±0.4	10.9±0.5	390±40	H_2
Ma12	-53.88	13.13	3.90±0.4	6.4±0.5	220±20	H_2
Ma13	-54.45	10.58	5.30±0.5	7.8±0.5	360±40	H_2
Ma14	-53.73	11.02	2.70±0.3	7.5±0.5	180±20	H_2
Ma15	-53.35	10.99	3.90±0.4	14.2±0.5	480±50	H_2
Ma16	-53.14	11.90	2.20±0.2	11.2±0.5	220±20	H_2
Ma17	-57.44	13.45	3.90±0.4	10.4±0.5	350±35	H_2
Ma18	-56.90	14.22	5.80±0.5	7.9±0.5	400±40	H_3
Ma19	-56.09	14.28	5.60±0.5	8.5±0.5	420±40	H_3
Ma20	-55.70	14.25	3.00±0.3	9.7±0.5	250±20	H_2
Ma21	-55.18	13.04	3.20±0.3	8.9±0.5	250±20	H_2
Ma22	-55.11	14.34	4.20±0.4	7.3±0.5	270±30	H_2
Ma23	-54.73	14.14	6.50±0.5	4.5±0.5	260±20	H_3
Ma24	-54.44	14.39	3.70±0.4	5.8±0.5	190±20	H_1
Ma25	-54.20	14.65	5.80±0.5	7.5±0.5	380±40	H_3
Ma26	-53.60	14.75	8.50±0.8	7.1±0.5	530±50	H_3
Ma27	-53.65	15.26	6.10±0.6	6.5±0.5	350±35	H_3
Ma28	-53.25	15.09	4.20±0.4	11.5±0.5	420±40	H_2
Ma29	-52.97	14.28	9.00±0.9	7.2±0.5	570±60	H_3
Ma30	-52.94	13.53	8.30±0.8	7.4±0.5	540±50	H_3
Ma31	-54.14	13.78	2.95±0.3	6.2±0.5	160±20	H_2

Visualization Tool (LTVT) software package by Mosher and Bondo [2006], we determined the selenographic positions of the examined domes.

LTVT is a freeware program that displays a wide range of lunar imagery and permits a variety of highly accurate measurements in these images. Selenographic coordinates, sizes, and shadow lengths of features can be estimated based on a calibration procedure. This calibration allows LTVT to make the spatial adjustments necessary to bring the observed positions of lunar features into conformity with those expected from the Unified Lunar Control Network (ULCN, 1994). The ULCN itself is a set of points on the lunar surface whose three-dimensional selenodetic coordinates (latitude, longitude, and radial distance from the lunar center) have been determined by careful measurement. Typically these points consist of very small craters.

In the proposed CCD images (figures 1 through 3), we can see several lunar domes with summit features. Some of these domes are quite smooth and low, while others are more rugged and heavily cratered. Ma32 is associated with a sinuous rille, while to the west of Ma40, a small undefined hill-like feature detectable in all CCD images is recognized as an isolated lunar cone based on the WAC imagery (Figure 4).

Morphometric Properties

GLD100 Dataset

Scholten et al. [2012] present a nearly global lunar DEM with a grid size of 100 m, the so-called "GLD100". This DEM has been constructed based on photogrammetric analysis of LROC WAC image pairs. The average elevation accuracy of the GLD100 amounts to 20 m, while 10 m accuracy is achieved for the nearside mare regions. The *ACT-REACT Quick Map* tool was used to access to the GLD100 dataset to obtain the cross-sectional profiles and the

Table 3. Morphometric properties of the ten volcanic constructed examined in the current study.

Dome	Longitude	Latitude	Slope [°]	Diameter [km]	Height [m]	Class
Ma32	-49.06	14.04	2.10±0.2	15.4±0.5	270±30	H_2
Ma33	-49.29	14.22	1.90±0.2	10.0±0.5	170±20	H_2
Ma34	-50.42	13.46	2.40±0.2	9.5±0.5	200±20	H_2
Ma35	-49.68	13.67	2.70±0.3	9.0±0.5	210±20	H_2
Ma36	-49.36	13.51	3.60±0.4	7.6±0.5	240±30	H_2
Ma37	-50.11	14.45	3.60±0.4	8.0±0.5	250±25	H_2
Ma38	-50.39	14.76	5.00±0.5	5.5±0.5	245±25	H_1
Ma39	-50.52	14.98	3.20±0.3	6.1±0.5	170±20	H_2
Ma40	-50.94	15.07	2.30±0.2	3.0±0.5	65±10	H_1
Cone	-51.11	15.12	5.10±0.5	1.8±0.5	80±10	cone

corresponding 3D views. The surface elevation plots derived for the examined domes are shown in Figure 5. The 3D reconstructions using WAC mosaic draped on top of the global WAC-derived elevation model (GLD100) are shown in Figure 6. Note that the flank slope derived for these domes is an average value, since the profile of most domes is somewhat asymmetric.

During our current study, we have used the GLD100 dataset to generate cross-sectional profiles of the domes Ma1-Ma31, comparing these new data to previous measurements obtained using only CCD telescopic images and the SfS approach. The results obtained using the recent probe's data confirm the morphometric properties previously derived for the domes reported in Table 2. Some of these cross-sectional profiles are shown in Figure 7.

Digital Elevation Map Based on Telescopic CCD Imagery

Generating an elevation map of a part of the lunar surface requires its 3D reconstruction. As previously stated, SfS is a well-known image-based method for 3D surface reconstruction. The SfS method requires accurate knowledge of the scattering properties of the surface in terms of the bidirectional reflectance distribution function (BRDF). A very simple model, the so-called "Lambert model", assumes perfectly diffuse scattering, implying intensity R_L of scattered light according to:

$$R_L(\rho, \theta_i) = \rho \cos \theta_i \quad (1)$$

with ρ as the surface albedo and θ_i as the angle between the surface normal and the direction of incident light. But the Lambert model does not correspond very well to the true scattering behavior of the lunar surface. A much more appropriate relation is the physically motivated BRDF by Hapke, which is based on the theory of radiative transfer [Hapke, 1993; Horn, 1989]. It allows conclusions about certain surface properties such as average particle size, particle density, albedo of the surface material, or macroscopic surface roughness. It is not straightforward, however, to directly employ the Hapke model for 3D reconstruction purposes. Therefore, in many astrogeologic applications the simple, empirical Lunar-Lambert law is used according to:

$$R_{LL}(\rho, \theta_i, \theta_e, \alpha) = \rho\,[2\,L(\alpha) \cos\theta_i / (\cos\theta_i + \cos\theta_e) + (1 - L(\alpha)) \cos\theta_i] \quad (2)$$

with θ_e as the angle between the surface normal and the viewing direction and the Lunar-Lambert parameter $L(\alpha)$ as an empirical value depending on the phase angle α. This model is a weighted sum of the Lommel-Seeliger and the Lambert BRDF. Given a suitable choice of $L(\alpha)$, the Lunar-Lambert law fits the true

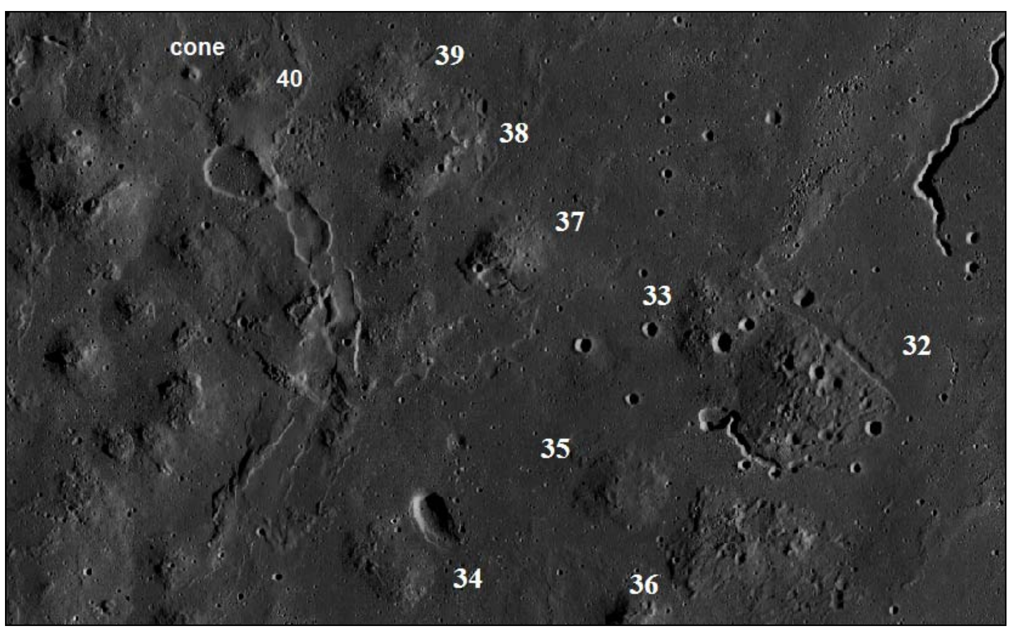


Figure 4. LROC WAC imagery of the region and the volcanic constructs described in the current study, including a lunar cone.

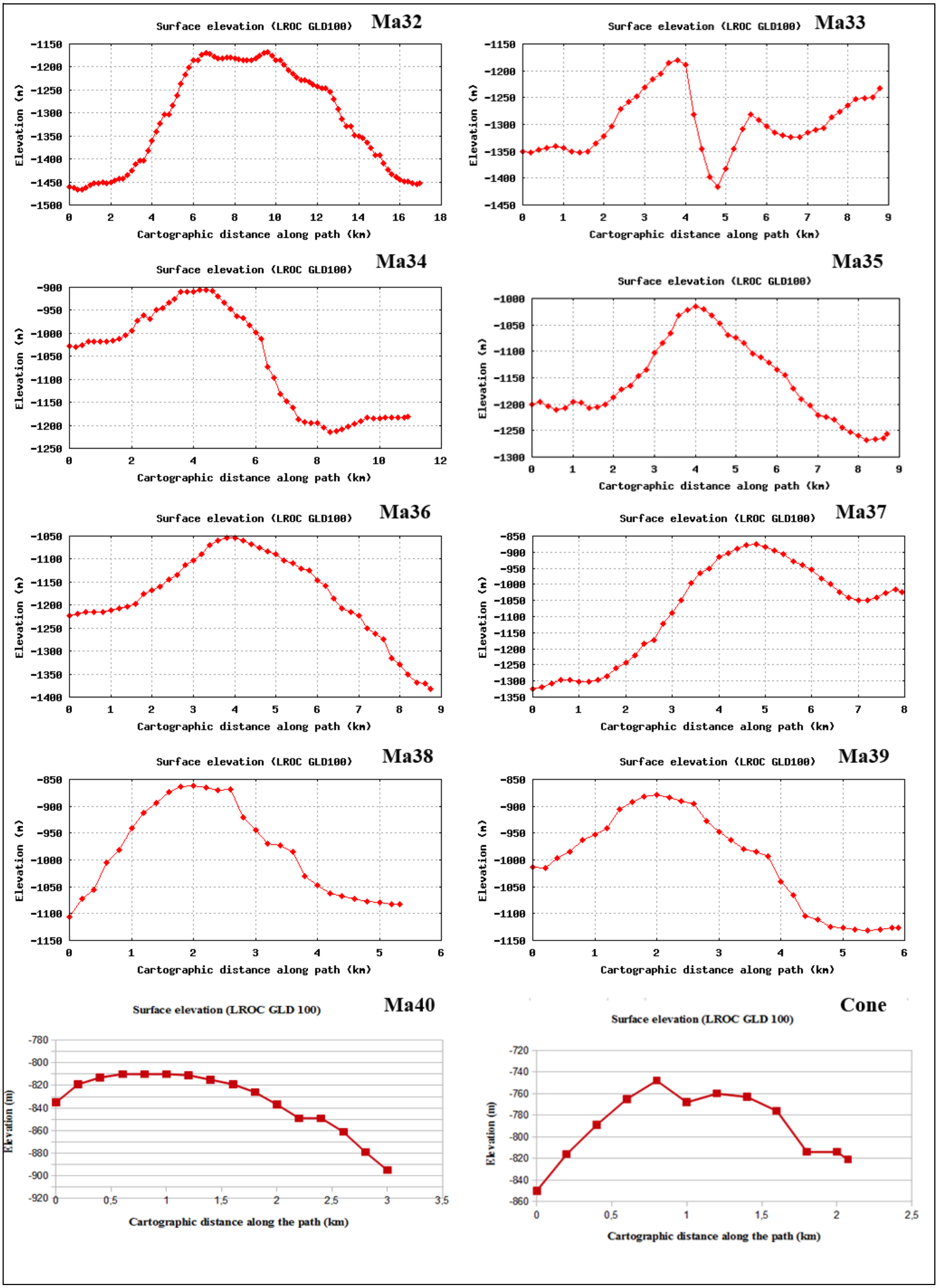


Figure 5. Cross-sectional profile in east-west direction based on GLD100 dataset for the examined domes and cone.

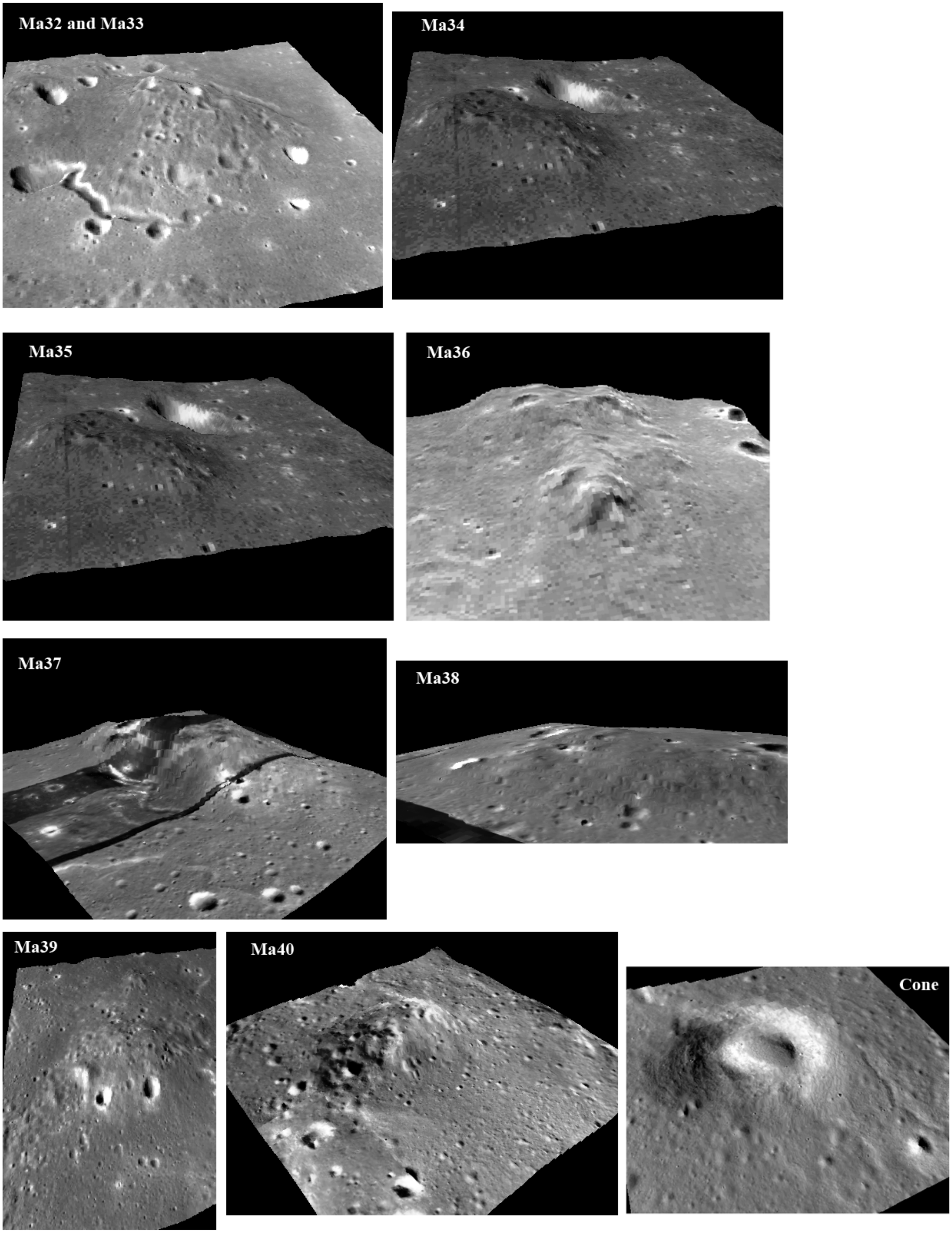


Figure 6: WAC draped on top of the global LROC WAC-derived elevation model (GLD100). The vertical axis is 5 or 10 times exaggerated.

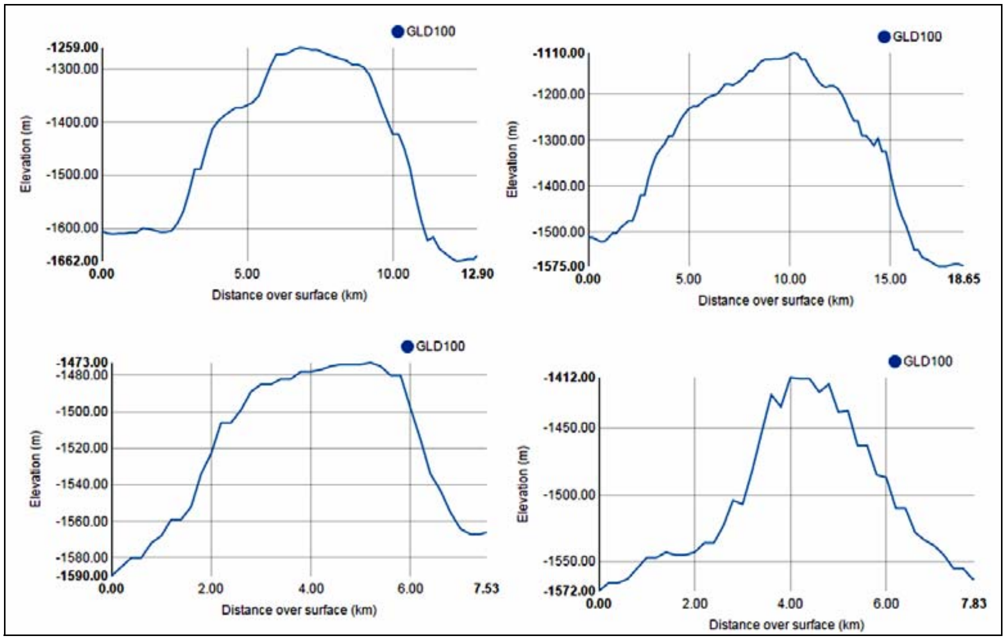


Figure 7. Cross-sectional profiles in east-west direction based on GLD100 dataset for some domes reported in Table 2. The figure displays the elevation for the domes Ma1 (top left), Ma 2 (top right), Ma3 (bottom left) and Ma4 (bottom right). Note the good agreement of the results with our CCD images based photoclinometry and shape from shading analysis (Table 2).

scattering behavior of a planetary surface equally well as the Hapke model. Values for L(α) have been tabulated by McEwen [1991] for planetary surfaces with a wide range of regolith properties. The height h of a dome was obtained by measuring the altitude difference in the reconstructed 3D profile between the dome summit and the surrounding surface, taking into account the curvature of the lunar surface. The average flank slope ζ was determined according to: $\zeta = \arctan 2h/D$. We have obtained the 3D reconstruction shown in Figure 8, which displays some of the examined domes. Our height values are in good correspondence with those obtained by GLD100 dataset with a difference of ± 5 percent.

In this study, we also have computed the height of some domes using the shadow length method according to the relation $h = l \tan \alpha$, where l is the shadow length, corrected for foreshortening and measured in km, and tan α the tangent of the solar altitude. For these measures, the LTVT software package was used. The calibration, based on ULCN 1994 data, allows LTVT to make the spatial adjustments necessary to bring the observed positions of lunar features into conformity with those expected from the Unified Lunar Control Network (ULCN).

Accordingly, for the domes termed Ma37-Ma38 and for the recognized lunar cones, heights of 245 m, 240 m and 75 m were obtained, respectively. Note that these values are slightly lower than the height values obtained with the photoclinometry and SfS method since the shadow only partially covers the western flank of the domes and therefore does not account for the full dome height.

Spectral Properties

1. Variations in soil composition, maturity, particle size, and viewing geometry are indicated by the reflectance R_{750} at 750 nm wavelength. Another important spectral parameter is the R_{415}/R_{750} ratio, which is correlated with the variations in TiO_2 content of mare soils. The third spectral parameter considered, the R_{950}/R_{750} ratio, is related to the strength of the mafic absorption band, representing a measure for the FeO content of the soil and being also sensitive to the optical maturity of mare and highland materials [Lucey et al., 1998].

   The color ratio image [Belton et al., 1992] is obtained by assigning the R_{750}/R_{415}, R_{750}/R_{950} and R_{415}/R_{750} into the red, green, and blue channels of a color image, respectively (Figure 9). The lunar highlands are depicted in red (old) and blue (younger). In the color ratio image, the *maria* are depicted in yellow/orange (iron-rich, lower titanium) or blue (iron-rich, higher titanium). Clementine UVVIS data reveal that the surfaces of the examined domes consist of spectrally blue mare lavas with R_{415}/R_{750} ratios, related to TiO_2 content, between 0.62 and 0.67. This broad range indicates the presence of several distinct units in the complex due to eruptions from different source regions [Lena et al., 2013].

2. The Christiansen Feature (CF) from gridded data record (GDR) level 3 data product of Diviner Lunar Radiometer Experiment/Lunar Reconnaissance Orbiter (DLRE/LRO) data were used for further analysis. The Lunar Reconnaissance Orbiter's (LRO) Diviner Lunar Radiometer Experiment has a spatial resolution of 950 m/pixel. Diviner produces thermal emissivity data, and can provide compositional information from three wavelengths centered on 8 µm which can be used to characterize the Christiansen Feature (CF), which is directly sensitive to silicate mineralogy and the bulk SiO_2 content. Silicic minerals and lithologies exhibit shorter wavelength positions at the 8 µm channel.

   For the study area, CF values of 8

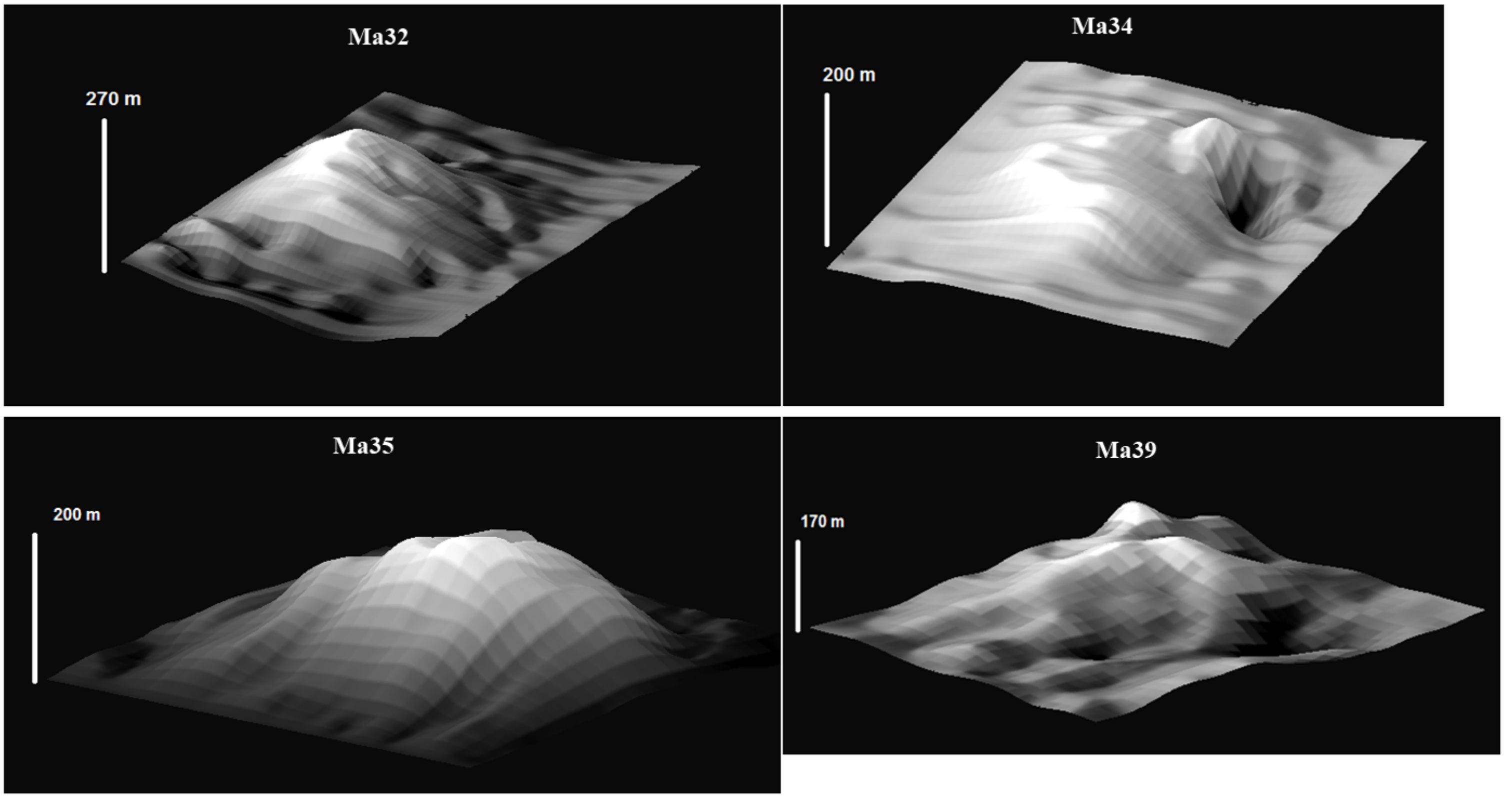


Figure 8. 3D reconstruction derived for the domes Ma32, Ma34, Ma 35 and Ma39 based on shape from shading (SfS) approach using the CCD image taken by Lena on April 8, 2017 22:53 UT (Fig. 2).The vertical axis is 10 times exaggerated.

μm are towards longer wavelength (CF~8.35-8.42 μm) indicating a less silicic, more basaltic composition. Average CF value of 8.16 μm are consistent with a mixture of plagioclase and some pyroxene, while the average CF values of maria basalts range from 8.3-8.45 μm.

3. Chandrayaan-1's Moon Mineralogy Mapper (M^3) is an imaging reflectance spectrometer that can detect 85 channels between 460 to 3,000 nm, and has a spatial resolution of 140 and 280 meter per pixel. In order to characterize the 1,000 nm band, we use a continuum removal method that enhances the characteristic of the 1,000 nm absorption band and more accurately shows the position of the band center. We fit a straight line between 750 and 1,500 nm to remove the continuum (Figure 10).

   Pyroxenes are characterized by distinct absorption bands around 1,000 and 2,000 nm, with low-calcium pyroxenes displaying bands shifted to slightly shorter wavelengths, and high-calcium pyroxenes exhibiting bands at slightly longer wavelengths with increasing Ca and Fe [Besse et al., 2014]. Olivine has a complex absorption centered near 1,000 nm, with no absorption at 2,000 nm. Therefore, olivine-rich lunar deposits are characterized by a broad 1,000 nm absorption band which is enhanced relative to the 2,000 nm band. The 1,000 nm band center of lunar glass is generally shifted to longer wavelengths when compared to pyroxene, and the 2,000 nm band center to shorter wavelengths. Thus, 1,000 and 2,000 nm band center positions of lunar glasses will typically appear closer together than those of pyroxenes [Besse et al., 2014].

Results and Discussion

The domes examined are characterized by spectra with a 1,000 nm absorption centered at 980-1,009 nm and 2,000 nm absorption centered at 2,120-2,220nm. Thus, the spectra of the domes Ma32-Ma40 indicate a classic basaltic signature (Table 4). The lunar cone shows the 1,000 nm absorption band centered at longer wavelength (1,025 nm) and 2,000 nm absorption band centers shifted to shorter wavelength (around 2,020 nm).

For comparison, continuum-removed laboratory spectra of green and orange lunar volcanic glass samples are also shown in Figure 11. The spectra of both volcanic glasses exhibit shifted absorption bands. The M^3 data show that for the examined domes, there is no evidence of volcanic glass signature, but their spectral signature is consistent with a mare basalts composition (Figure 11, adapted by the work of Besse et al. [2014]). On

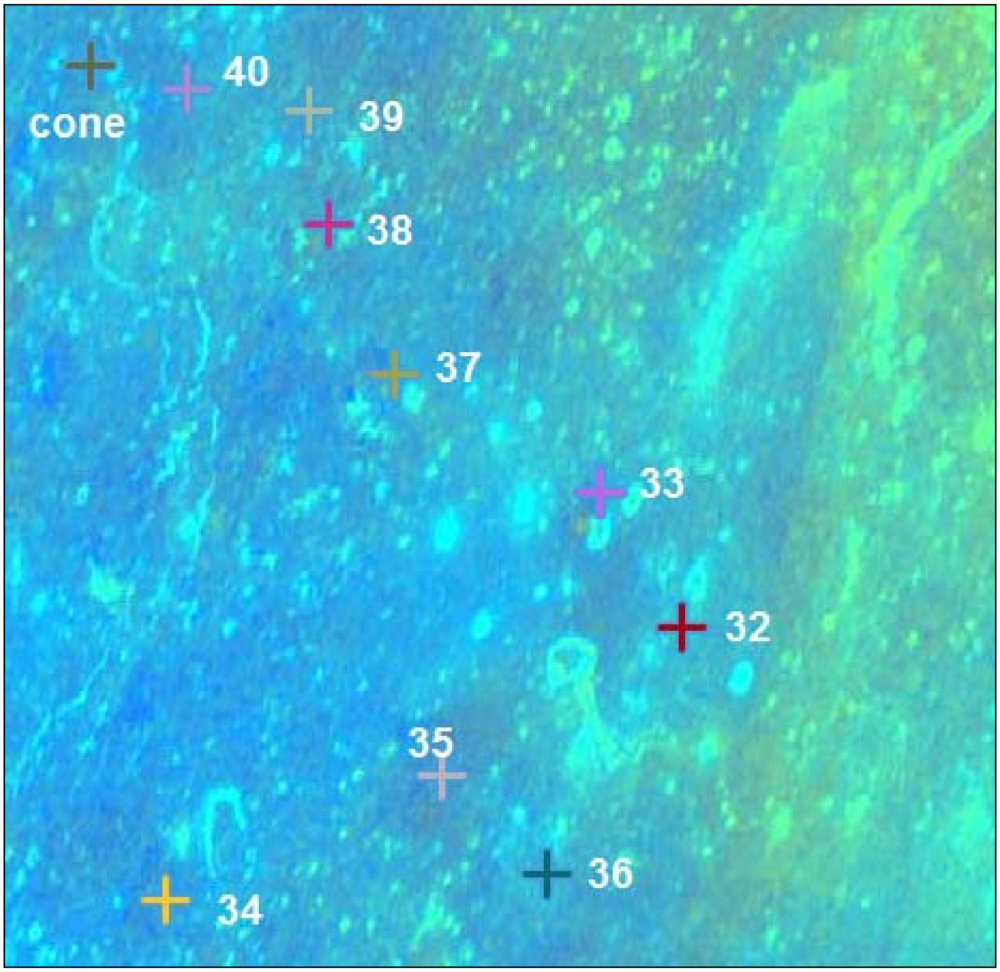


Figure 9. Clementine false color map obtained assigning the R_{750}/R_{415}, R_{750}/R_{950} and R_{415}/R_{750} into the red, green, and blue channels, respectively.

the other hand, the examined lunar cone is halfway between the volcanic glasses and the mare basalts. Thus the spectrum would indicate a glass spectral signature likely mixed with basalts material.

Moreover, 8 µm features measured by Diviner indicate that the domes are not rich in silica and are not significantly different than surrounding mare materials.

Based on the CCD images and the GLD100 dataset, we obtained diameters of 3.0-15.4 km for the lunar effusive domes examined in this study, moderate slopes of 1.9°- 2.7° for the domes termed Ma32-Ma35 and Ma40, and steeper slopes of 3.2°- 5.0° for the domes termed Ma36-Ma39. The examined lunar cone has a small diameter of 1.8 km, the height amounts to 80 m yielding an average flank slope of 5.1° (Table 3).

Lunar cones come in many shapes and sizes: circular (Osiris in Mare Serenitatis), breached cones with a short sinuous rille disappearing into the mare (Isis in Mare Serenitatis), and cones that are elongated and aligned along a rille [Lena et al., 2013]. The presence of lunar pyroclastic constructs implies that gas may be released from the erupted magma, causing disruption of the magma and subsequent dispersal of the clasts [Weitz and Head, 1999]. Several volcanic cones in the Marius Hills region have recently been characterized [Lawrence et al., 2012].

Marius Hills domes are a unique class with irregular shapes, complex surface details, and a few summit craters or cones on top of some domes. An example of a dome with a cone on the summit is Ma23. The summit cone is recognized using LROC WAC and NAC imagery (figures 12 through 14). We have identified this feature in some images. In particular, the image made by Wirths (cfr. Figure 3) displays many protrusions on the summit of several domes. It would be interesting to receive new images in order to verify if these subtle details can be resolved using earth-based telescopes of smaller diameter.

In previous works [Lena et al., 2013; Lena et al., 2009], a classification of the Marius Hills was introduced:

- Small domes with D < 6 km are assigned to subclass H_1. They are morphometrically similar to but spectrally bluer than similar domes situated in the Milichius/T. Mayer region.
- Domes of subclass H_2 with D > 6 km and slopes < 5.5° morphometrically resemble the steep domes of class B_1 situated north of the crater Hortensius [Lena et al., 2013], but their irregular shapes also indicate a formation during several effusive episodes.
- Domes of subclass H_3 have diameters comparable to those of monogenetic class B_1 domes, but their flank slopes are all steeper than 5.5°.

Some domes have small diameters < 6 km (Ma5, Ma24, Ma38 and Ma40) and flank slopes comprised from 3.5° to 5.3° (class H_1). Most of the domes in this region have diameters > 6 km and flank slopes below 5.5° and belong to class H_2. Only some domes (Ma1, Ma18-19, Ma23, Ma25-27 and Ma29-30) have flank slopes steeper than 5.5° and reach values of up to 9° (class H_3).

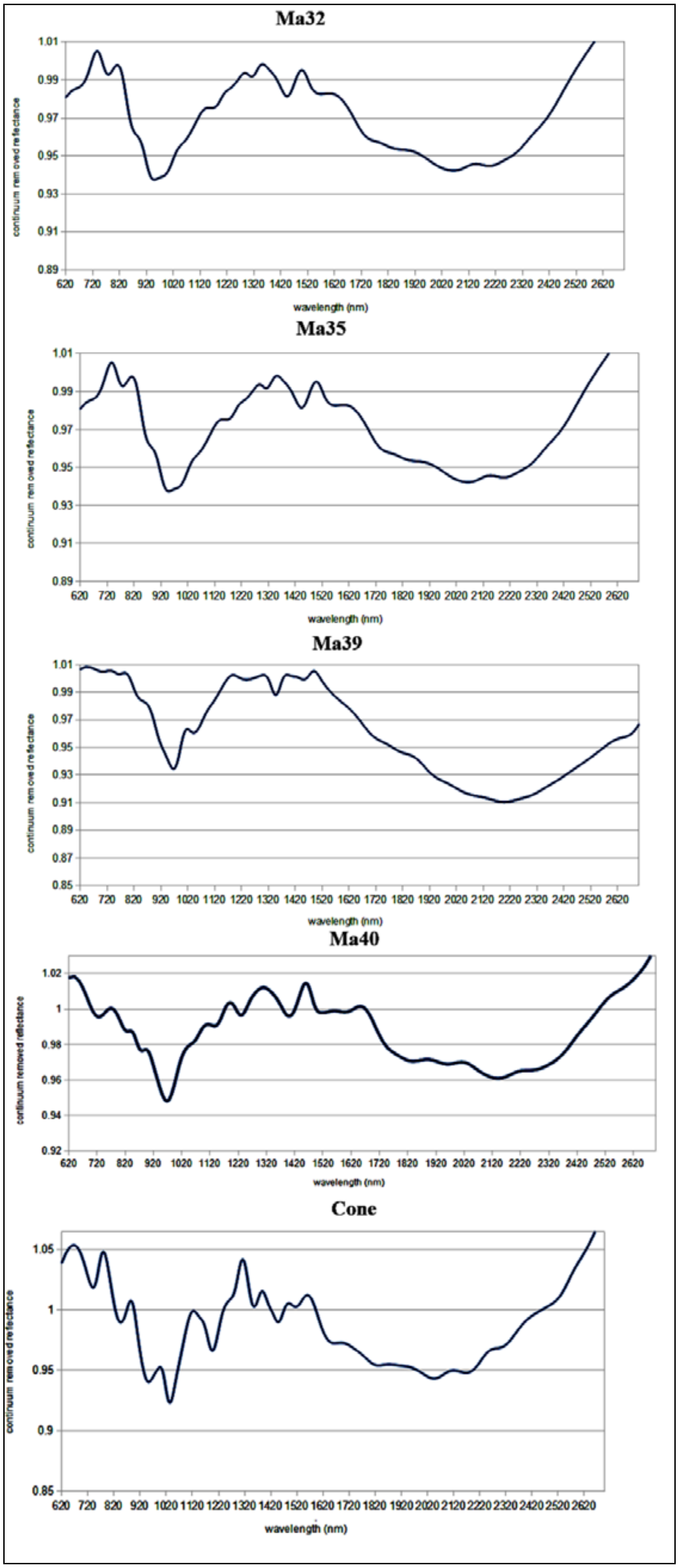


Figure 10. M^3 spectral analysis of the domes Ma32, Ma35, Ma39-40 and the lunar cone.

Table 4. Spectral properties of the examined domes and of two areas of dark material derived from M³ data.

Dome	M³ absorptions band centers (nm)	Glass signature
Ma32	980 and 2,120	No, basaltic composition
Ma35	1,009 and 2,220	No, basaltic composition
Ma39	990 and 2,220	No, basaltic composition
Ma40	990 and 2,200	No, basaltic composition
Cone	1,025 and 2,020	Yes, mixed with mare basalt signature

Based on our available data, 10% of the analyzed domes belong to class H_1, 70% belong to class H_2 and 20% belong to steeper domes of class H_3, demonstrating that in the wide Marius shield, domes of different shapes and slopes occur together. The monitoring conducted allowed us to characterize part of the Marius domes. A goal of this program will be to map the other volcanic edifices located in this wide region and to characterize their morphometric and spectral properties. It will also be interesting to compare the resolution reached with images taken by terrestrial telescopes and CCD cameras. The recording of finer details will be obtained with telescopes optically of high quality, large aperture, and favorable observing sites in order to reduce the effect of atmospheric turbulence.

As a final note, there are so many domes in the Marius Hills region that we cannot include them all in a single report. All ALPO members are encouraged to participate with their own observations as this will be an ongoing project, which include future updates and reports.

References

[1] Belton, M.J.S., Klaasen, K.P., Clary, M.C., Anderson, J.L., Anger, C.D., Carr, M.H., Chapman, C.R., Davies, M.E., Greeley, R., Anderson, D., Bolef, L.K., Townsend, T.E., Greenberg, R., Head, J.W., Neukum, G., Pilcher, C.B., Veverka, J., Gierasch, P.J., Fanale, F.P., Ingersoll, A.P., Masursky, H., Morrison, D., Pollack, J.B., 1992. "The Galileo solid-state imaging experiment." *Space Science Reviews*. 60, 413-455. https://link.springer.com/article/10.1007/BF00216864

[2] Besse, S., Sunshine, J.M. and L. R. Gaddis, 2014. "Volcanic glass signatures in spectroscopic survey of newly proposed lunar pyroclastic deposits," *Journal of Geophysical Research: Planets*, 119, doi:10.1002/2013JE004537. http://planetary.brown.edu/pdfs/Besse-Lunar%20Pyroclastic%20Glasses-jgre20209-1.pdf

[3] Eliason, E., Isbell, C., Lee, E., Becker, T., Gaddis, L., McEwen, A., Robinson, M.: Mission to the Moon: the Clementine UVVIS Global Mosaic. PDS Volumes USANASA PDS CL 4001 4078. https://www.mapaplanet.org/explorer/help/data_set.html#moon_clementine_multi

[4] Green, R.O., Pieters, C.M.,Mouroulis, P., Eastwood, M., Boardman, J., Glavich, T., Isaacson, P.J., Annadurai, M., Besse, S., Barr, D., Buratti, B.J., Cate, D., Chatterjee, A., Clark, R., Cheek, L., Combe, J.P., Dhingra, D., Essandoh, V., Geier, S., Goswami, J.N., Green, R., Haemmerle, V., Head, J.W., Hovland, L., Hyman, S., Klima, R.L., Koch, T., Kramer, G.Y., Kumar, A.S.K., Lee, K., Lundeen, S., Malaret, E.,McCord, T.B.,McLaughlin, S.,Mustard, J.F., Nettles, J.W., Petro,N.E., Plourde, K., Racho, C., Rodriquez, J., Runyon, C., Sellar, G., Smith, C., Sobel, H., Staid, M.I., Sunshine, J.M., Taylor, L.A., Thaisen, K., Tompkins, S., Tseng, H., Vane, G., Varanasi, P., White, M.,Wilson, D., 2011.

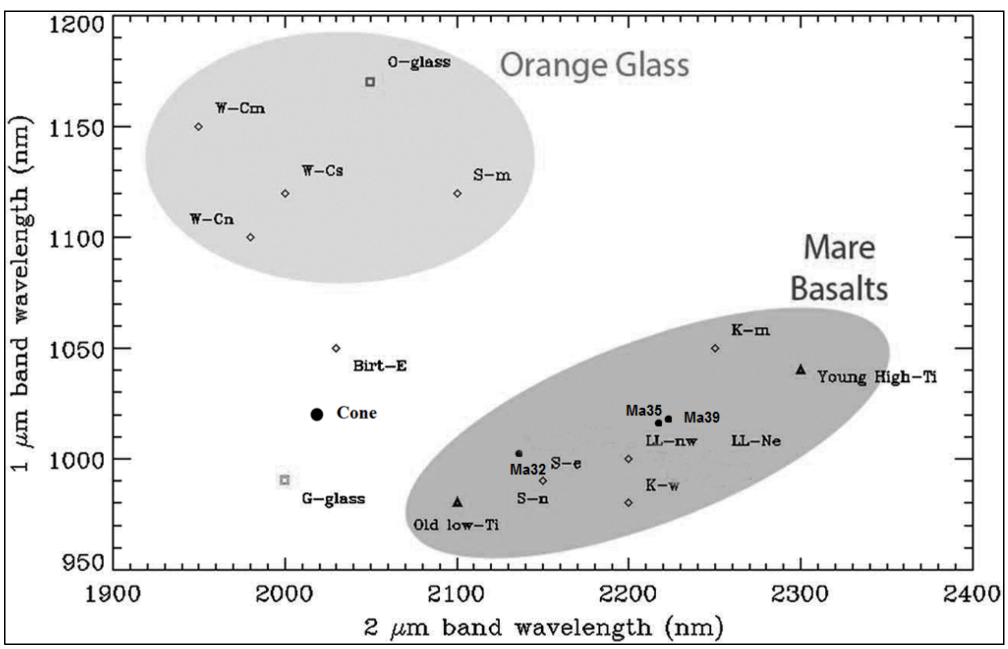


Figure 11. Diagram of the band position at 1 and 2 µm. The positions are extracted from the continuum-removed spectra. As reported in Table 4, the domes display a basaltic composition. The lunar cone shows a glass signature likely mixed with a basaltic signature.

"The Moon Mineralogy Mapper (M^3) imaging spectrometer for lunar science: instrument description, calibration, on-orbit measurements, science data calibration and on-orbit validation." *Journal of Geophysical Research*. 116, E00G19, *http://dx.doi.org/10.1029/2011JE003797*.

[5] Hapke, B., 1993. Theory of reflectance and emittance spectroscopy. Cambridge, UK Cambridge University Press. *https://doi.org/10.1017/CBO9781139025683*

[6] Horn, B. K. P., "Height and Gradient from Shading," MIT technical report, AI memo no. 1105A, 1989. *http://people.csail.mit.edu/people/bkph/AIM/AIM-1105A-TEX.pdf*

[7] Isaacson, P., Besse, S., Petro, N., Nettles, J., and the M3 Team: "M3 Data Tutorial November 2011." *http://pds-imaging.jpl.nasa.gov/documentation/Isaacson_M3_Workshop_Final.pdf*.

[8] Lawrence, S. J., Stopar, J. D., Hawke, B. R., Jolliff, B. L., Robinson, M. S., Spudis, P. D. and Giguere, T. A., "Characterizing volcanic cones in the Marius Hills region." 43th Lunar and Planetary Science Conference (2012). Abstract #2432. *https://www.lpi.usra.edu/meetings/lpsc2012/pdf/2432.pdf*

[9] Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., 2013. "Lunar domes: Properties and Formation Processes," Springer Praxis Books. *http://www.springer.com/gp/book/9788847026360*

[10] Lena, R., Lunar domes, chapter in Encyclopedia of Lunar Science. Editor: Brian Cudnik, 2015, Springer ISBN: 978-3-319-05546-6. *https://www.springer.com/us/book/9783319145402*

[11] Lena, R., Wöhler, C. and Phillips, J., 2009. "Marius Hills: Morphometry, Rheology, and Mode of Emplacement." EPSC Abstracts, Vol. 4, EPSC2009-262, European Planetary Science Congress. *http://adsabs.harvard.edu/abs/2009epsc.conf..262L*

[12] Lucey, P.G., Blewett, D.T., Hawke, B.R., 1998. Mapping the FeO and TiO2 content of the lunar surface with multispectral imagery. *Journal of Geophysical Research*. 103 (E2), 3679-

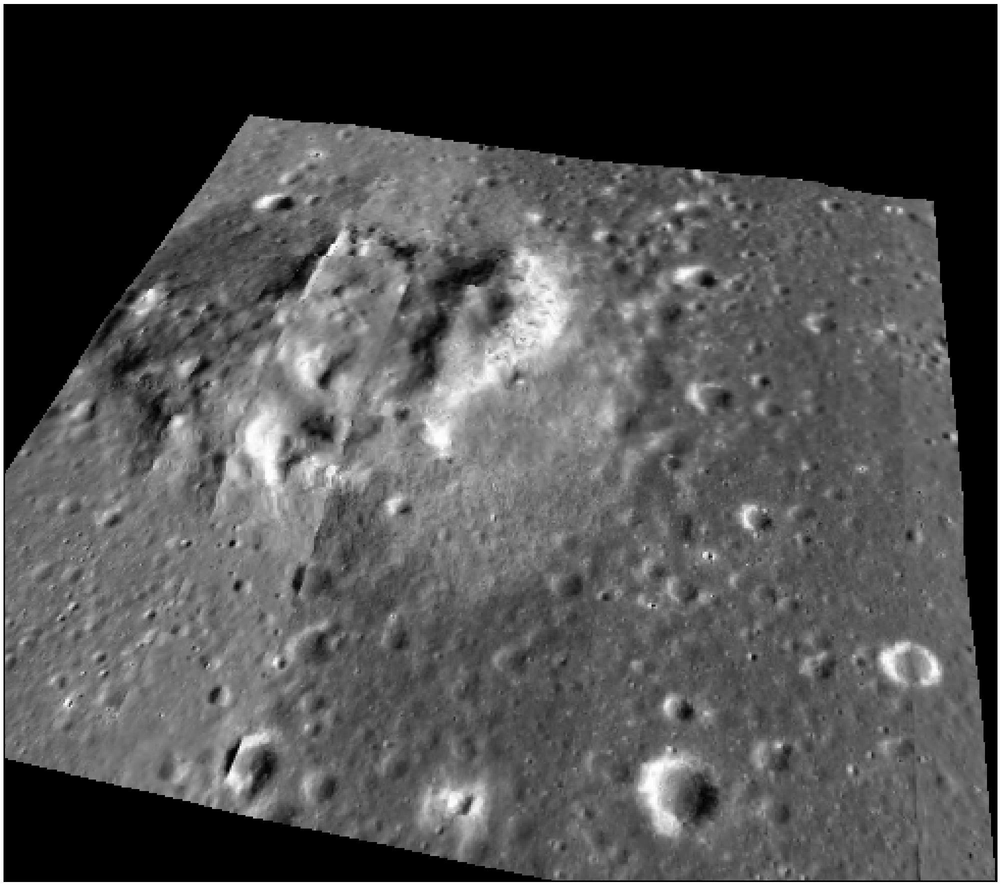


Figure 12. WAC draped on top of the global LROC WAC-derived elevation model (GLD100) of Ma23. The vertical axis is 5 times exaggerated. A cone is visible as a protrusion on the summit.

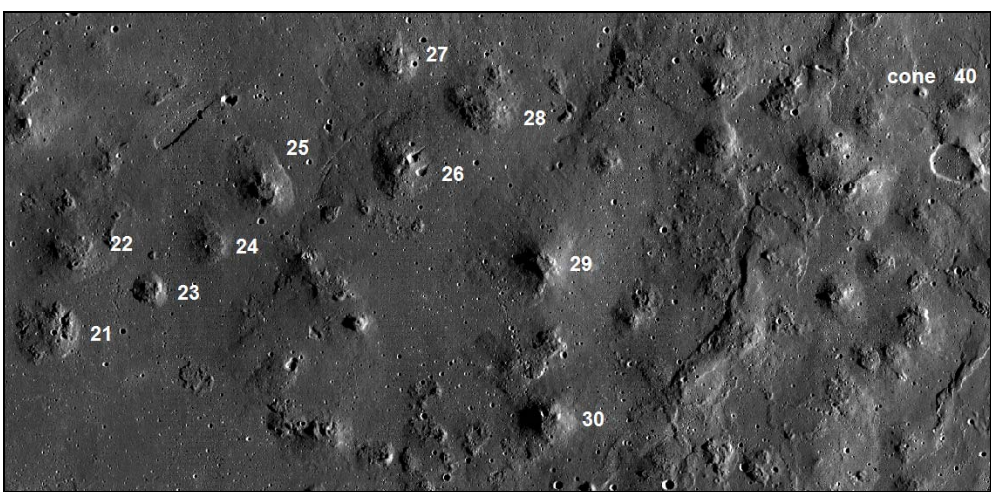


Figure 13. LROC WAC imagery of the region including Ma21-Ma30. Ma 23 displays a cone on the summit as visible in the 3D reconstruction reported in Figure 12.

3699. http://adsabs.harvard.edu/abs/1998JGR...103.3679L

[13] McBride, M.J., Horgan, B.H.N, Lawrence, S.J., 2018. "Spectral analysis of lunar cinder cones in the Marius Hills volcanic complex." 49th Lunar Planetary Science Conference, abstract #2798. https://www.hou.usra.edu/meetings/lpsc2018/pdf/2798.pdf

[14] McEwen, A. S., 1991. "Photometric Functions for Photoclinometry and Other Applications". *Icarus*, 92, 298-311. https://pubs.er.usgs.gov/publication/70016679

[15] Mosher, J., & Bondo, H., 2006. Lunar Terminator Visualization Tool (LTVT). http://ltvt.wikispaces.com/Downloads

[16] Phillips, J., 1990, "The Marius Hills region - A unique lunar dome field." Journal of the Assn of Lunar & Planetary Observers. Vol. 34, July 1990, p. 104-108. http://adsabs.harvard.edu/abs/1990JALPO..34..104P

[17] Scholten, F., Oberst, J., Matz, K.-D., Roatsch, T.,Wählisch,M., Speyerer, E.J., Robinson, M.S., 2012. "GLD100: the near-global lunar 100m raster DTM from LROC WAC stereo image data." *Journal of Geophysical Research*. 117 (E00H17), http://dx.doi.org/10.1029/2011JE003926.

[18] Spudis, P. D., P. J. McGovern and W. S. Kiefer, 2013. "Large shield volcanoes on the Moon," *Journal of Geophysical Research: Planets*, 118, 1063-1081, doi:10.1002/jgre.20059. http://adsabs.harvard.edu/abs/2013JGRE..118.1063

[19] Weitz, C.M., Head, J.W., 1999. "Spectral properties of the Marius Hills volcanic complex and implications for the formation of lunar domes and cones." *Journal of Geophysical Research.* 104 (E8), 18933-18956. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/1998JE000630#references-section

[20] Wöhler, C., Lena, R., & Phillips, J., 2007. "Formation of lunar mare domes along crustal fractures: Rheologic conditions, dimensions of feeder dikes, and the role of magma evolution." *Icarus*, 189 (2), 279-307. http://adsabs.harvard.edu/abs/2007Icar..189..279W

[21] Wöhler, C., Lena, R., Lazzarotti, P., Phillips, J., Wirths, M., & Pujic, Z., 2006. "A combined spectrophotometric and morphometric study of the lunar mare dome fields near Cauchy, Arago, Hortensius, and Milichius." ', 183, 237-264. https://www.sciencedirect.com/science/article/pii/S0019103506000960?via%3Dihub

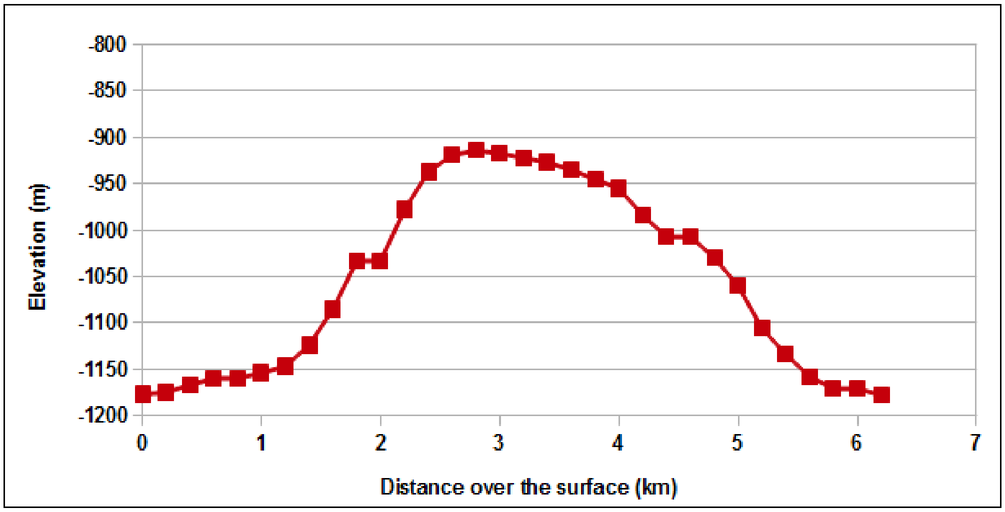


Figure 14. Cross-sectional profiles in east-west direction based on GLD100 dataset for Ma23, which include a cone on the summit.

ALPO Lunar Dome Observation Form

Submit electronically (attach images and scanned drawings to e-mail) to:
Raffaello.Lena@alpo-astronomy.org
or via regular mail to:
Raffaello Lena
Cartesio 144 D
00137 Rome, Italy

Observers Name:	**Last:**					**First:**				
Date: (UD)	**Month:**			**Day:**				**Year:**		
Time: (UT)	**(UT) Hours:**					**(UT) Minutes:**				
Colongitude:										
Region Observed:										
Telescope:	**Size (Inches or Cm.):**					**Type:**				
Eyepieces Used:								**Filters:**		
Seeing (Circle)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Transparency:										
Type of Observation (list details):	**Visual:**					**Photographic:**				

Domes Observed (Positions)

Xi	Eta	OR	Lunar Long.	Lunar Lat.

Notes: (**Include observer location here (City, State, and Country):** Use back if necessary):

Feature Story:

Galilean Satellite Eclipse Timings: The 2011 - 2012 Apparition

By: John E. Westfall,
Former Program Coordinator,
Galilean Satellite Eclipses
johnwestfall@comcast.net

Abstract

During the 2011/2012 Jupiter apparition, four observers made 85 visual timings of the eclipses of three of Jupiter's Galilean satellites - Io, Europa and Ganymede. We compare the means of their observed eclipse disappearance and their reappearance times with the predictions of the IMCCE (Institut de Méchanique Céleste et de Calcul des Éphémérides) E-5 ephemeris.

Introduction

The apparition covered here is the 34nd observed by the ALPO Jupiter Section's Galilean Satellite Eclipse Timing Program, which conducts visual timings of the eclipses by Jupiter of the four Galilean satellites Io, Europa, Ganymede and Callisto (note that Callisto did not undergo eclipses in 2011/12). Our observers timed the "last speck" visible when a satellite entered Jupiter's shadow (*disappearance*) and the "first speck" visible when it emerged from eclipse (*reappearance*). Each satellite's mean disappearance and reappearance timings were then averaged to determine if its position corresponded to its ephemeris. (Our 1998/99 Apparition report described in detail our method of reduction, which also cited the reports for the previous apparitions. [Westfall 2009: 40, 42, 48; see also Westfall 2012, 2015, 2016a, 2016b, 2017, 2018a and 2018b.]) We have compared our reduced timings with the IMCCE predictions, using the INPOP13C planetary theory and Lieske E-5 satellite theory.

Table 1 lists the pertinent dates and other circumstances of the 2011-12 Apparition. Figure 1 shows a scale diagram of the orbits of the Galilean satellites.

Table 1. Circumstances of the 2011/12 Jupiter Apparition

Apparition		Observing Season	
Initial solar conjunction	2011 APR 06, 15h	First eclipse timing§	2011 JUN 28 (+83d)
First maximum phase angle	2011 AUG 01, 00h (11.88°)	Last eclipse timing§	2012 MAR 25 (-49d)
Closest approach to Earth†	2011 OCT 27, 19h (D = 49.6")	Duration	271d
Opposition to the Sun*	2011 OCT 29, 02h (δ = +11.9°)	Solar Elongation Range	062°W – 037°E
Second maximum phase angle	2012 JAN 22, 12h (11.40°)	Sources: Meeus 2015; *Astronomical Almanac*, 2011 and 2012 editions; JPL *HORIZONS* website. Dates and times throughout this report are in Universal Time (UT).	
Final solar conjunction	2012 MAY 13, 13h		
Zenocentric latitude of Sun	+3.06° - +3.55°(Max. +3.57°, 2012 MAR 10)	* δ = Jupiter's declination at opposition. † D = Jupiter's equatorial diameter in arc-seconds. § In parentheses are the number of days after initial solar conjunction (+) or before final solar conjunction (-).	
Zenocentric latitude of Earth	+2.81° - +3.36°(Max. +3.89°, 2011 OCT 01)		

All Readers

Your comments, questions, etc., about this report are appreciated. Please send them to: ken.poshedly@alpo-astronomy.org for publication in the next Journal.

Online Features

Left-click your mouse on:

- The author's e-mail address in blue text to contact the author of this article.
- The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Observing Scales

Standard ALPO Scale of Intensity:
- 0.0 = Completely black
- 10.0 = Very brightest features
- Intermediate values are assigned along the scale to account for observed intensity of features

ALPO Scale of Seeing Conditions:
- 0 = Worst
- 10 = Perfect

Scale of Transparency Conditions:
- Magnitude of the faintest star visible near Jupiter when allowing for moonlight and twilight

This apparition saw the Sun and Earth reach their northernmost latitudes relative to Jupiter's equator, which lies very near the orbital planes of the Galilean satellites. This circumstance meant that Callisto did not undergo eclipses in 2011/12, while Ganymede

Table 2. Number of Eclipse Timings, 2011/12 Apparition

Number of Timings	85
Timings before Opposition	37 (44%)
Timings after Opposition	48 (56%)
Disappearance Timings	36 (42%)
Reappearance Timings	49 (58%)

entered and left Jupiter's shadow at highly oblique angles. The high terrestrial and solar latitudes, combined with Jupiter having recently passed through perihelion (2011 March 17), meant that both disappearance and reappearance were observable for some eclipses of Europa, a fairly rare situation.

Observations and Observers

The 85 timings received for 2011/12 brought our 34-apparition total to 11,029 observations, and show a welcome increase from the 80 received for the 2010/11 Apparition. Table 2 gives descriptive statistics for the 2011/12 observations.

Compared with 2010/11, there is a greater imbalance between the number of observations made following opposition and of those made before. This inequality is understandable, given the inconvenience of observing after midnight, but the statistical significance of our results would be improved were the observations more evenly distributed.

Table 3 lists the participants in our program during 2011/12, with their nationalities, instrument apertures and number of timings, both short-term and long-term.

It is pleasing to see that all our observers, although small in number, have continued with our program for multiple apparitions. We retain our international participation with half our observers residing outside the United States.

The contributors used a variety of telescopes in the aperture range 6-35.6 cm. Smaller telescopes were used more frequently than in most previous apparitions; the mean aperture, weighted by number of observations, was 13.7 cm.

Timings Analysis: Satellite Positions

The individual eclipse timings made by our participants in 2011/12 are listed in

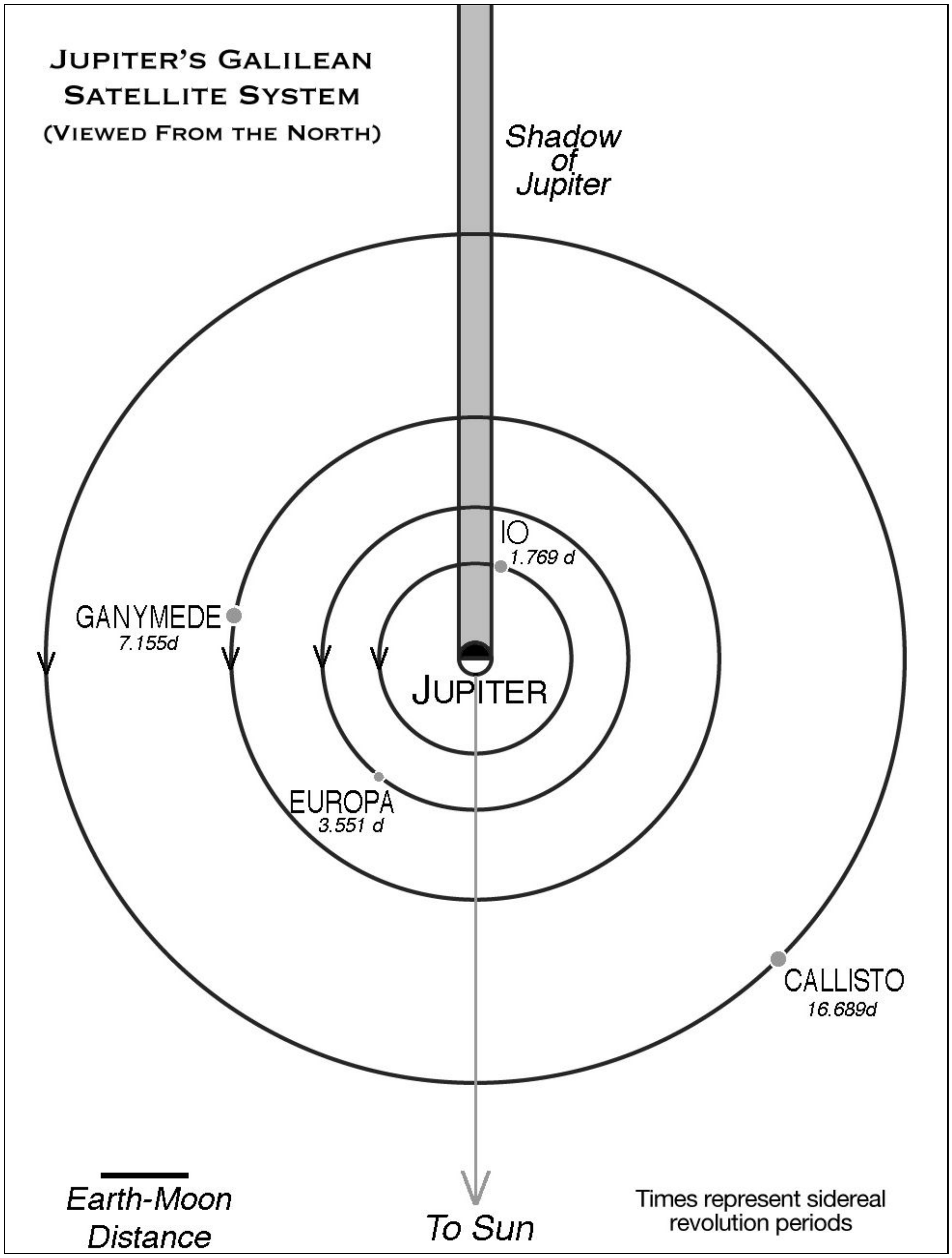


Figure 1. Diagram of the Galilean satellite system.

Table 5 at the end of this report. Table 4, below, summarizes the eclipse timings made in this period, with the means, standard errors of the means, and medians of the differences ("residuals") between our timings and the IMCCE E-5 ephemeris. All the residuals were corrected for oblique contact with Jupiter's shadow at disappearance and reappearance, using the formula $R' = R \cos \beta'$, where R' is the corrected residual, R the original residual, and β' the zenographic latitude of the satellite relative to Jupiter's shadow. This correction made a difference of at most 8 seconds for Io, up to 29 seconds for Europa, but reached as high as 281 seconds for Ganymede.

In 2011/12, Io and Ganymede closely followed the IMCCE E-5 ephemeris. Europa, however, continued its long-known deviation from the E-5 model, its observed events averaging 10 seconds later than predicted.

Conclusion

The analysis of our program's timings made during the 2011/12 Jupiter apparition showed that the times of eclipses by Jupiter of Io and Ganymede did not differ significantly from the IMCCE E-5 ephemeris. Europa's observed timings, however, disagreed significantly from the ephemeris.

We thank the observers who contributed timings during 2011/12 and hope that they continue with our program. We also invite others who are interested in this visual observing program, which requires only modest-sized telescopes, to contact the new program coordinator (Richard Schmude at *schmude@gordonstate.edu*).

References

Meeus, Jean (2015). *Astronomical Tables of the Sun, Moon and Planets.* 3rd ed. Richmond, VA: Willmann-Bell.

United States Naval Observatory (2010). *The Astronomical Almanac for the Year 2011*. Washington: U.S. Government Printing Office.

________ (2011). *The Astronomical Almanac for the Year 2012*. Washington: U.S. Government Printing Office.

Westfall, John E. (2009). "Galilean Satellite Eclipse Timings During the 1998/99 Apparition." *Journal of the Assn of Lunar & Planetary Observers*, 51 (3): 38-48. *http://www.alpo-astronomy.org/djalpo/51-3/JALPO51-3%20-%20Free.pdf*

________. (2012). "Galilean Satellite Eclipse Timings During the 1999/2000 Apparition." *Journal of the Assn of Lunar & Planetary Observers*, 54 (4): 45-54.*http://www.alpo-astronomy.org/djalpo/* [Password: occultation]

________. (2015). "Galilean Satellite Eclipse Timings: The 2000/01 Apparition." *Journal of the Assn. of Lunar & Planetary Observers*, 57 (4): 37-47.

________ (2016a). "Galilean Satellite Eclipse Timings: The 2001-2004 Apparitions." *Journal of the Assn. of Lunar & Planetary Observers*, 58 (2): 50-60.

________ (2016b). "Galilean Satellite Eclipse Timings: The 2004-05, 2005-06 and 2006-07 Apparitions." *Journal of the Assn. of Lunar & Planetary Observers*, 58 (4): 44-52

________ (2017). "Galilean Satellite Eclipse Timings: The 2007-09 Apparition." *Journal of the Assn. of Lunar & Planetary Observers,* 59 (4): 57-60.

________ (2018a). "Galilean Satellite Eclipse Timings: The 2009-10 Apparition." *Journal of the Assn. of Lunar & Planetary Observers,* 60 (2): 57-60.

________ (2018b). "Galilean Satellite Eclipse Timings: The 2010-11 Apparition." *Journal of the Assn. of*

Table 3. Participating Observers, 2011/12 Apparition

Observer and Telescope					ALPO Timing Program Total	
I.D. No.	**Name**	**Nationality**	**Telescope Aper. (cm)**	**Number of Timings (total)**	**Number of Apparitions**	**Number of Timings**
1a 1b 1c	Abbott, A.P.	Canada	8 15 32	1 2 2 (5)	12	39
2a 2b	Hays, R.H., Jr.	USA (IL)	13 15	5 25 (30)	21	328
3a 3b 3c	Parl, M.	Germany	6 9 10	4 5 29 (38)	7	189
4a 4b	Westfall, J.	USA (CA)	12.7 35.6	7 5 (12)	31	568
Mean Number of Timings per Observer				21.2		

Table 4. Timing Residual Statistics, 2011/12 Apparition

Quantity	Satellite		
	Io	**Europa**	**Ganymede**
Disappearances: Number of Timings	17 (16)	10 (8)	9 (7)
Disappearances: Mean	+98.4±1.6s	+122.0±4.5s	+252.7±2.8s
Disappearances: Median	+100.5s	+123.0s	+252.0s
Reappearances: No. of Timings	18 (17)	19 (16)	12 (11)
Reappearances: Mean	-102.9±2.2s	-101.3±5.9s	-254.6±4.6s
Reappearances: Median	-104.0s	-113.0s	-252.0s
(Disap.+Reap.)/2: Means	-2.3±1.1s	+10.3±3.7s*	-0.9±2.7s
(Disap.+Reap.)/2: Medians	-1.8s	+5.0s	0.0s

Numbers of timings in parentheses are the numbers used in the analysis after those with unusually large residuals (most often due to poor observing conditions) were omitted. In the row labeled "(Disap.+Reap.)/2: Means", * shows a mean observed-predicted difference that is significantly different from 0 at the 5-percent level of confidence.

Table 5. Galilean Satellite Eclipse Timings, 2011/12 Apparition

UT	LD	Lat	ObN	STB	Dif	UT	LD	Lat	ObN	STB	Dif	UT	LD	Lat	ObN	STB	Dif
Io Disappearances						**Io Reappearances – cont.**						**Europa Reappearances – cont.**					
10805	24	+20	3c	111	+107	20116	23	+21	3c	010	-124	20106	36	+35	4b	100	-162
10810	24	+20	4a	000	+93				3a	011	-83	20113	36	+35	4b	100	-128
			2a	000	+111	20122	23	+21	2b	000	-113	20116	36	+36	3a	110	-87
10821	24	+20	3c	211	+107	20129	22	+21	2b	200	-115	20131	34	+36	2b	000	-138
10826	24	+20	2b	000	+110	20208	21	+21	3c	120	-106	20207	33	+36	1a	001	-58
10828	24	+20	3c	111	+106	20325	12	+21	3c	110	-105	20310	23	+36	4a	100	-98
10902	23	+20	2a	000	+109	**Europa Disappearances**						20320	19	+36	3c	210	-141
10911	21	+20	2b	000	+113	10712	34	+29	2b	000	+131	**Ganymede Disappearances**					
10913	21	+20	3c	210	+106	10830	36	+31	3c	111	+151	10915	47	+57	3a	210	+344
10921	18	+20	3c	110	+109	10914	32	+31	2b	000	+155	11020	10	+59	3b	020	+469
10925	17	+20	1b	000	+96	10924	27	+31	3c	010	+161	11028	3	+59	1c	201	+57
10927	16	+20	3c	111	+108	11002	22	+32	3c	011	+154	11125	6	+60	3c	210	+500
10928	16	+20	3c	111	+106	11009	17	+32	2b	000	+137	11202	12	+60	2b	000	+534
11004	14	+20	2a	000	+104	11016	11	+32	1c	001	+118	11210	17	+60	2a	000	+514
11014	8	+20	3b	111	+91	11023	6	+32	2b	001	+135	20114	30	+61	2b	000	+538
11020	6	+20	4a	000	+48	20113	2	+34	4b	100	+79	20122	30	+61	2b	100	+527
11021	5	+20	3b	111	+98	20116	2	+34	3a	101	+18	20219	21	+62	3c	210	+522
Io Reappearances						**Europa Reappearances**						**Ganymede Reappearances**					
11030	2	+20	3b	120	-59	10712	1	+30	4a	100	+116	10628	21	+53	2b	000	-414
11108	6	+20	3c	210	-100	10816	2	+31	3c	221	-95	10727	30	+54	3c	111	-427
11112	8	+20	2b	100	-103	10824	1	+31	3c	121	-75	10810	32	+55	2a	000	-449
11114	9	+20	2b	000	-105	11103	5	+34	4a	100	-41				4a	000	-405
11201	17	+21	3c	211	-119	11106	9	+34	3b	220	-92	10915	19	+57	2b	100	-463
11207	18	+21	2b	000	-116	11110	11	+34	2b	000	-138				1b	000	-361
11208	19	+21	3c	221	-111				4a	000	-83	11104	8	+59	2b	101	-458
11215	21	+21	3c	210	-111	11120	19	+34	3c	210	-141	11118	24	+59	3c	110	-559
11230	23	+21	2b	010	-105	11208	29	+34	3c	110	-156	11125	32	+60	3c	210	-536
20106	23	+21	4b	100	-118	11212	32	+35	2b	000	-143	20115	54	+61	2b	000	-546
20113	23	+21	4b	000	-117	11215	32	+35	3c	210	-146	20212	46	+62	3c	210	-532
20114	23	+21	2b	000	-121	11230	36	+35	2b	000	-146	20227	40	+62	2b	100	-517

Column headings: UT = Universal Time, expressed as ymmdd, where y is the last digit of the year; LD = distance of satellite from Jupiter's limb in arc seconds; Lat = zenographic latitude of satellite on Jupiter's shadow cone in degrees; ObN = observer number as in Table 3; STB = observing conditions, where S = seeing, T = transparency and B = field brightness, all expressed in terms of 0 = condition not perceptible, 1 = condition perceptible but does not affect accuracy and 2 = condition perceptible and does affect accuracy; and Dif = (observed – calculated) eclipse time in seconds. Underlined timings were excluded during analysis due to unusually large differences from the other observations, usually due to unfavorable observing conditions. Note that these "raw" residual values have not been corrected for oblique contact with Jupiter's shadow.

Lunar & Planetary Observers, 60 (3): 75-78.

ALPO Galilean Satellite Eclipse Visual Timing Report Form

Describe your time source(s) and estimated accuracy	Observer Name: Apparition: 20_____-20_____ (conjunction to conjunction)

Event Type (a)	Predicted UT		Observed UT Time (9d)	Telescope Data (e)			Sky Conditions (0-2 scale) (f)			Notes (g)
	Date (b)	Time (c)		Type	Aperture (cm)	Mag.	Seeing	Transparency	Field Brightness	

(a) 1 = Io, 2 = Europa, 3 = Ganymede, 4 = Callisto; D = Disappearance, R = Reappearance
(b) Month and Day
(c) *Predicted* UT to 1 minute
(d) *Observed* UT to 1 second; corrected to watch error if applicable; indicate in "Notes" if Observed UT date differs from Predicted UT date
(e) R = Refractor, N = Newtonian Reflector, C = Cassegrain Reflector, X = Compound/Catadioptric System; indicate in "Notes" if other type.
(f) These conditions, including field brightness (due to moonlight, twilight, etc.), should be described as they apply to the actual field of view, rather than to general sky conditions. Use whole numbers only, as follows:
0 = Condition not perceptible; no effect on timing accuracy
1 = Condition perceptible; possible minor effect on timing accuracy
2 = Condition serious; definite effect on timing accuracy
(g) Include here such factors as wind, drifting cloud(s), satellite near Jupiter's limb, moonlight interference, etc.

At the end of the apparition, return this form to:
John E. Westfall, ALPO Assistant Jupiter Coordinator, P.O. Box 2447, Antioch, CA 94531-2447 USA
E-mail to: johnwestfall@comcast.net

Papers & Presentations:

ALPO Observations of Saturn During the 2013 - 2014 Apparition

By Julius L. Benton, Jr.,
Coordinator, ALPO Saturn Section
jlbaina@msn.com

This paper includes a gallery of Saturn images submitted by a number of observers.

Please note that when a visual observer records or suspects a specific feature on Saturn, it is important to secure future observations quickly if we wish to obtain the period of rotation. For this purpose we encourage observers to use these facts: In System I (EZ plus NEB or SEB), 7 rotations are accomplished in close to 3 Earth-days, while in System II (rest of planet), 9 rotations require close to 4 such days.

A complete set of Saturn Observing Forms are available for downloading at http://www.alpo-astronomy.org/publications/ALPO Section Publications/SaturnReportForms - All.pdf

See the ALPO Resources Section, ALPO Observing Section Publications of this Journal for hardcopy availability.

Abstract

The ALPO Saturn Section received 287 visual observations and digital images for the 2013-14 apparition spanning the period from December 27, 2013 through October 08, 2014. Observations were submitted by 32 observers situated in Australia, Brazil, Colombia, France, Germany, Greece, Italy, Japan, New Zealand, Philippines, Poland, South Africa, United Kingdom and United States. Instruments utilized for the observations ranged in aperture from 12.8 cm (11.0 in.) up to 106.0 cm (41.7 in.). Imaging during 2013-14 revealed discrete activity such as diffuse bright areas within Saturn's North Tropical Zone (NTrZ) and North Temperate Zone (NTeZ), as well as white spots in the EZn (Equatorial Zone, northern half). A recurring dark condensation or spot in the North Temperate Zone (NTeZ) was imaged during 2013-14, plus a lesser prominent dark spot in the North North Temperate Zone (NNTeZ). Of continuing interest

Table 1. Geocentric Phenomena in Universal Time (UT) for Saturn During the 2013-2014 Apparition

Conjunction		2013	Nov	06^{d}
Opposition		2014	May	10^{d}
Conjunction			Nov	18^{d}
Opposition Data				
Visual Magnitude		+0.1		
Constellation		Libra		
B		+21.6º		
B’		+21.8º		
Globe	Equatorial Diameter	18.6″		
	Polar Diameter	16.6″		
Rings	Major Axis	42.2″		
	Minor Axis	15.5″		

All Readers

Your comments, questions, etc., about this report are appreciated. Please send them to: ken.poshedly@alpo-astronomy.org for publication in the next Journal.

Online Features

Left-click your mouse on:

• The author’s e-mail address in blue text to contact the author of this article.
• The references in blue text to jump to source material or information about that source material (Internet connection must be ON).

Observing Scales

Standard ALPO Scale of Intensity:
0.0 = Completely black
10.0 = Very brightest features
Intermediate values are assigned along the scale to account for observed intensity of features
Ring B has been adopted (for most apparitions) as the standard on the numerical sequence. The outer third is the brightest part of Ring B, and it has been assigned a constant intensity of 8.0 in integrated light (no filter). All other features on the globe and in the rings are estimated using this standard of reference.

ALPO Scale of Seeing Conditions:
0 = Worst
10 = Perfect

Scale of Transparency Conditions:
Magnitude of the faintest star visible near Saturn when allowing for daylight and twilight

IAU directions are used in all instances (so that Saturn rotates from west to east).

Table 2: Contributing Observers, 2013-2014 Apparition of Saturn

	Observer	Location	No. of Observations	Telescopes Used
1.	Abel, Paul G.	Leichester, UK	4 2	20.3 cm (8.0 in.) NEW 50.8 cm (20.0 in.) DALL
2.	Arditti, David	Middlesex, UK	2	35.6 cm (14.0 in.) SCT
3.	Barry, Trevor	Broken Hill, Australia	70	40.6 cm (16.0 in.) NEW
4.	Benton, Julius L.	Wilmington Island, GA	27	15.2 cm (6.0 in.) REF
5.	Collins, Maurice	Palmerston North, NZ	3	20.3 cm (8.0 in.) SCT
6.	Combs, Brian	Buena Vista, GA	2	35.6 cm (14.0 in.) SCT
7.	da Silva, Vlamir	San Paolo, Brazil	19	20.3 cm (8.0 in.) SCT
8.	Delcroix, Marc	Tournefeuille, France	4 2	32.0 cm (12.6 in.) NEW 106.0 cm (41.7 in.) CAS
9.	Foster, Clyde	Centurion, South Africa	13	35.6 cm (14.0 in.) SCT
10.	Go, Christopher	Cebu City, Philippines	3	35.6 cm (14.0 in.) SCT
11.	Hill, Rik	Tucson, AZ	7	20.3 cm (8.0 in.) MAK
12.	Hoffler, Wyckliffe	Titusville, FL	1	35.6 cm (14.0 in.) SCT
13.	Hood, Mike	Kathleen, GA	2	20.3 cm (8.0 in.) REF
14.	Ikemura, Toshihiko	Osaka, Japan	4	38.0 cm (15.0 in.) NEW
15.	Jakiel, Richard	Douglasville, GA	1	30.5 cm (12.0 in.) SCT
16.	Kardasis, Manos	Athens, Greece	6	28.0 cm (11.0 in.) SCT
17.	Legrand, Michel	La Baule, France	1	21.0 cm (8.3 in.) SCT
18.	Malinski, Piotr	Warsaw, Poland	2	35.6 cm (14.0 in.) SCT
19.	Maxson, Paul	Phoenix, AZ	46 17	25.0 cm. (9.8 in.) DALL 35.6 cm. (14.0 in.) SCT
20.	Melillo, Frank J.	Holtsville, NY	3	25.4 cm (10.0 in.) SCT
21.	Niechoy, Detlev	Göttingen, Germany	11	20.3 cm (8.0 in.) SCT
22.	Peach, Damian	Norfolk, UK	8	35.6 cm (14.0 in.) SCT
23.	Pellier, Christophe	Bruz, France	1	25.0 cm (9.8 in.) CAS
24.	Plante, Phil	Braceville, OH	3	25.4 cm (10.0 in.) NEW
25.	Rome, Joseph	Austin, TX	2	28.0 cm (11.0 in.) SCT
26.	Sasse, Hugh	Leichester, UK	1	50.8 cm (20.0 in.) DALL
27.	Siedentop, Steve	Grayson, GA	1	12.8 cm (5.0 in.) REF
28.	Sweetman, Michael E.	Tucson, AZ	9	12.8 cm (5.0 in.) REF
29.	Triana, Charles	Bogota, Colombia	3	25.4 cm (10.0 in.) SCT
30.	Walker, Gary	Macon, GA	1	25.4 cm (10.0 in.) REF
31.	Wesley, Anthony	Murrumbateman, Australia	5	36.8 cm (14.5 in.) NEW
32.	Zannelli, Carmelo	Palermo, Italy	1	35.6 cm (14.0 in.) SCT
	TOTAL OBSERVATIONS		**287**	
	TOTAL OBSERVERS		**32**	

Instrumentation Abbreviations:
NEW = Newtonian, SCT = Schmidt-Cassegrain, MAK= Maksutov-Cassegrain, REF = Refractor, DALL = Dall-Kirkham, CAS = Cassegrain

have been amateur images of the remarkable hexagonal feature at Saturn's North Pole at different wavelengths. Views of the major ring components, including Cassini's and Encke's divisions, were much improved this apparition due to the very favorable ring tilt toward Earth since 2012-13. ALPO Saturn observers maintained their involvement in our cooperative Pro-Am imaging campaign at various wavelengths, including routine active participation by visual observers, as we monitor activity on Saturn's globe and submit results to Cassini scientists. The inclination of Saturn's ring system toward Earth, B, attained a maximum value of +22.7° on February 23, 2014, and therefore, more of the planet's Northern Hemisphere and North face of the rings were seen to advantage during 2013-14. A summary of visual observations and digital images of Saturn contributed during the apparition are discussed, including the results of persistent efforts to try to image the curious bi-colored aspect and azimuthal brightness asymmetries of the rings. Accompanying the report are references, drawings, photographs, digital images, graphs and tables.

Introduction

This report is derived from an analysis of 287 visual observations, descriptive notes and digital images contributed to the ALPO Saturn Section by 32 observers from December 27, 2013 through October 08, 2014, referred to hereinafter as the 2013-14 "observing season" or apparition of Saturn. Examples of submitted drawings and images are included with this report, integrated as much as feasible with topics discussed in the text, with times and dates all given in Universal Time (UT).

Table 1 provides geocentric data in Universal Time (UT) for the 2013-14 apparition. The numerical value of **B**, or the Saturnicentric latitude of the Earth referred to the ring plane (+ when north), ranged between the extremes of +22.7° (February 23, 2014) and +21.0° (July 10, 2014). The value of **B'**, the Saturnicentric latitude of the Sun, varied from +20.9° (December 27, 2013) to +23.1° (October 8, 2014).

Figure 1

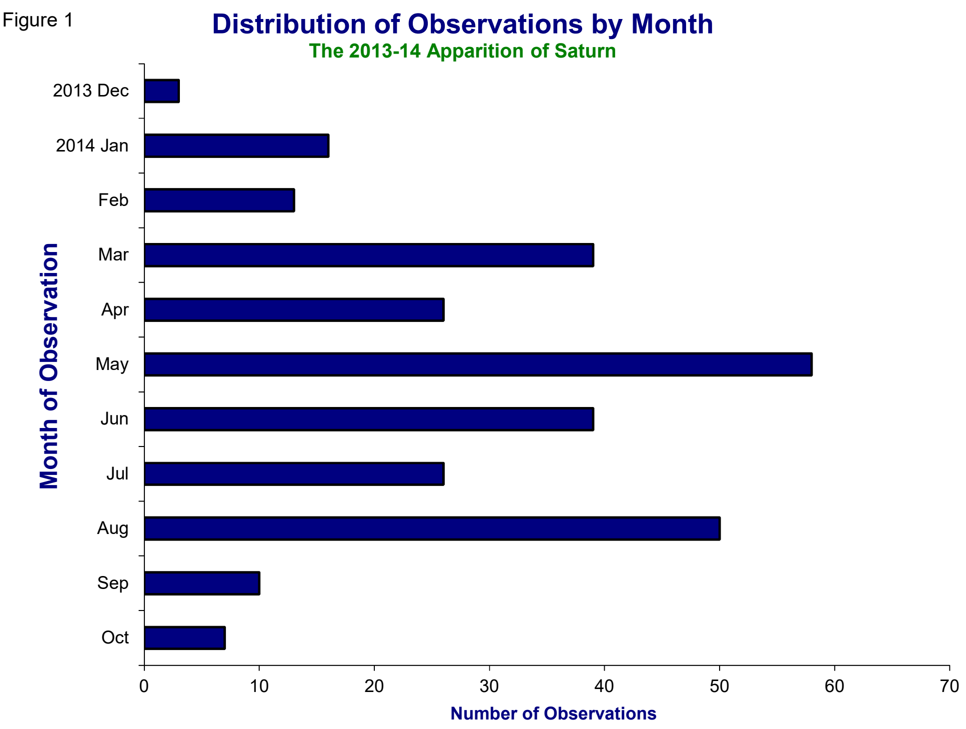


Figure 2

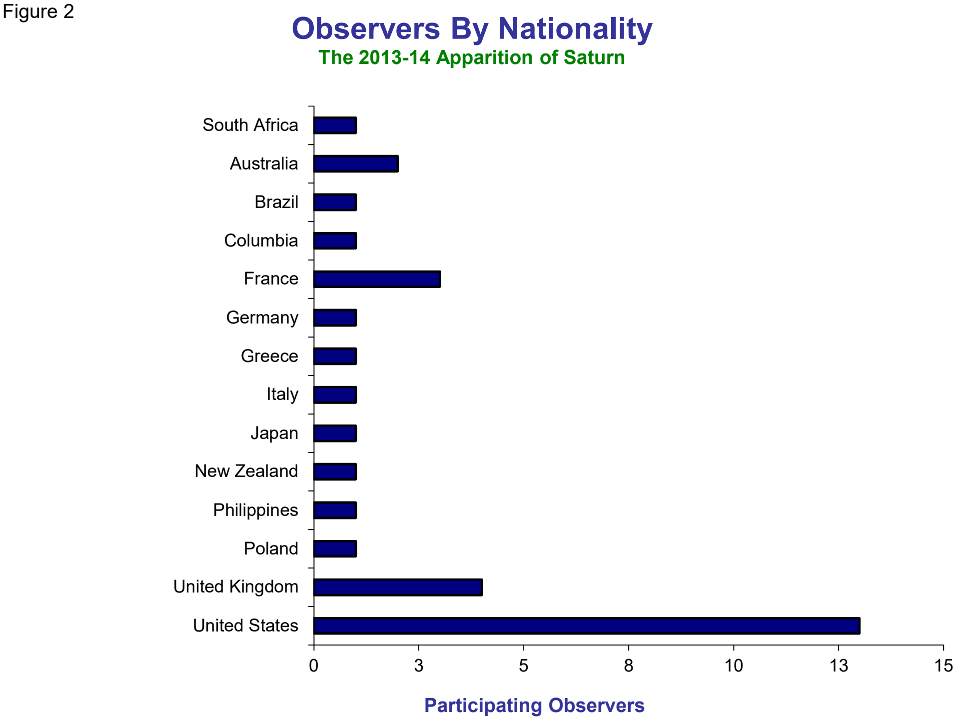


Table 2 lists the 32 individuals who sent 287 reports to the ALPO Saturn Section this apparition, along with their observing sites, number of observations, telescope apertures and type of instrument. Figure 1 is a histogram of the distribution of observations by month showing that 38.3% were made prior to opposition, 2.1% at opposition (May 10, 2014) and 59.6% thereafter. Although observers tend to mainly view Saturn at or near opposition when the planet is well-placed and high in the evening sky, coverage favored a wider span of time around opposition during the 2013-14 apparition (82.9% of all observations took place from early March through late August 2014). To accomplish the best overall coverage, observers are continually urged to start viewing and imaging Saturn as soon as the planet is visible in the eastern sky before sunrise following conjunction with the Sun. The goal is to maintain a well-balanced observational surveillance of the planet for as much of its mean synodic period of 378d as possible (this period refers to the elapsed time from one conjunction of Saturn with the Sun to the next, which is slightly longer than one terrestrial year).

Figure 2 and Figure 3 show the ALPO Saturn Section observer base and the international distribution of all observations submitted during the apparition. The United States accounted for 40.6% of the participating observers and 42.5% of the submitted observations. International cooperation continued to be very good this observing season, with 59.4% of all observers residing in Australia, Brazil, Colombia, France, Germany, Greece, Italy, Japan, New Zealand, Philippines, Poland, South Africa and United Kingdom, whose total contributions represented 57.5% of the observations.

Figure 4 graphs the number of observations by instrument type in 2013-14. Slightly less than half (46.3%) of all observations were made with telescopes of classical design (refractors, cassegrains, Newtonians and Gregorians), while the remaining 53.7% were completed with catadioptrics (Schmidt-Cassegrains, Maksutov-Cassegrains and Dall-Kirkhams).

Telescopes with apertures ranging from 12.8 cm (11.0 in.) through 106.0 cm (41.7 in.) were employed for recording

Figure 3

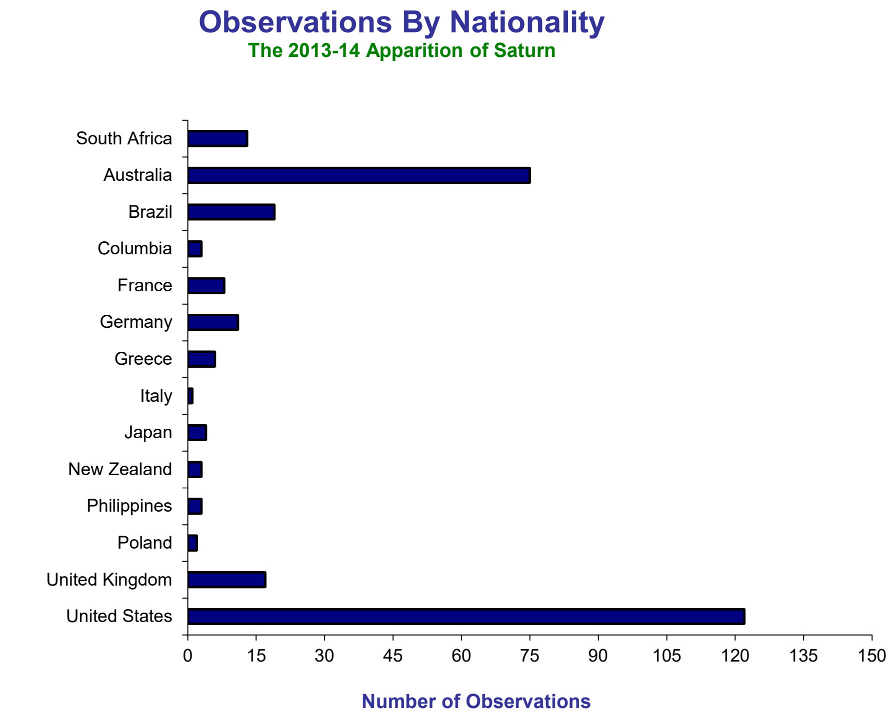


Figure 4

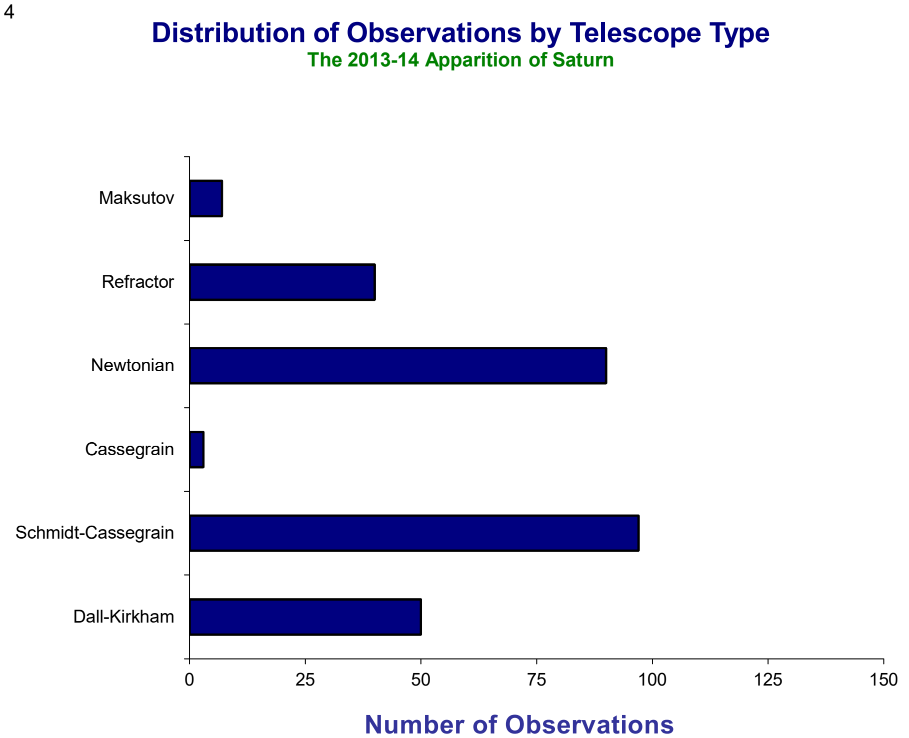


Table 3: Visual Numerical Relative Intensity Estimates and Colors for the 2013-14 Apparition of Saturn

Globe/Ring Feature	# Estimates	2013-14 Mean Intensity & Standard Error	Intensity Difference Since 2012-13	Mean Derived Color
Zones				
EZn	3	7.67 ± 0.14	-0.29	Bright Yellowish-White
NTrZ	1	7.00 ± 0.00	+0.67	Light Yellowish-White
NPR	7	4.36 ± 0.13	-0.14	Gray
Belts				
NEBw (whole)	4	3.88 ± 0.10	-0.18	Dull Yellowish-Brown
NEBs	6	2.42 ± 0.14	-0.30	Dark Grayish-Brown
NEBn	4	3.13 ± 0.32	-0.88	Grayish-Brown
NTeB	1	4.00 ± 0.23	-0.40	Grayish-Brown
Globe N of Rings	7	5.71 ± 0.09	-0.14	Light Yellowish-Gray
Rings				
A (whole)	7	4.43 ± 0.07	-0.22	Dull Grayish-White
B (outer 1/3)	7	8.00 ± 0.00 **STD**	0.00	Brilliant White
B (inner 2/3)	6	6.08 ± 0.08	-0.57	Yellowish-White
Ring C (ansae)	4	2.13 ± 0.21	-0.21	Very Dark Gray
Crape Band	7	3.00 ± 0.27	+0.40	Dull Gray
Sh G on R	7	0.00 ± 0.00	0.00	Black shadow

Notes:
For nomenclature, see text and Figure 5. A letter with a digit (e.g. A0 or B10) refers to a location in the ring specified in terms of units of tenths of the distance from the inner edge to the outer edge. Visual numerical relative intensity estimates (visual surface photometry) are based upon the ALPO Intensity Scale, where 0.0 denotes complete black (shadow) and 10.0 refers to the most brilliant condition (very brightest Solar System objects). The adopted scale for Saturn uses a reference standard of 8.0 for the outer third of Ring B, which appears to remain stable in intensity for most ring inclinations. All other features on the Globe or in the rings are compared systematically using this scale, described in the Saturn Handbook, which is issued by the ALPO Saturn Section. The "Intensity Difference Since 2012-13" is in the same sense of the 2012-13 value subtracted from the 2013-14 value, "+" denoting an increase (brightening) and "-" indicating a decrease (darkening). When the apparent change is less than about 3 times the standard error, it is probably not statistically significant.

observations this apparition. Readers are reminded, however, that there are numerous past instances where smaller instruments of good quality have been successfully utilized for many of our Saturn observing programs.

The ALPO Saturn Section truly appreciates all of the digital images, visual drawings, descriptive reports and supporting data submitted by observers listed in Table 2 for the 2013-14 apparition. Without this dedicated teamwork, this report would not have been possible. Those wishing to join us in our various Saturn observing programs using visual methods in the form of drawings, intensity, latitude estimates and CM (central meridian) transit timings, as well as routine digital imaging, are encouraged to do so in forthcoming observing seasons. The domestic and international flavor of our observational work is most encouraging, and our focus is to maintain participation by observers everywhere. All methods of recording observations are crucial to the success of our programs, whether one's preference is sketching Saturn at the eyepiece or simply writing descriptive reports, making visual numerical relative intensity or latitude estimates, or pursuing dedicated digital imaging. The ALPO Saturn Section emphasizes especially the ongoing need for more experienced observers to carry out regular visual numerical relative intensity estimates in integrated light and with standard color filters. Such estimates, which are simple to do, are greatly needed for maintaining our data for a continuing comparative analysis of belt, zone and ring

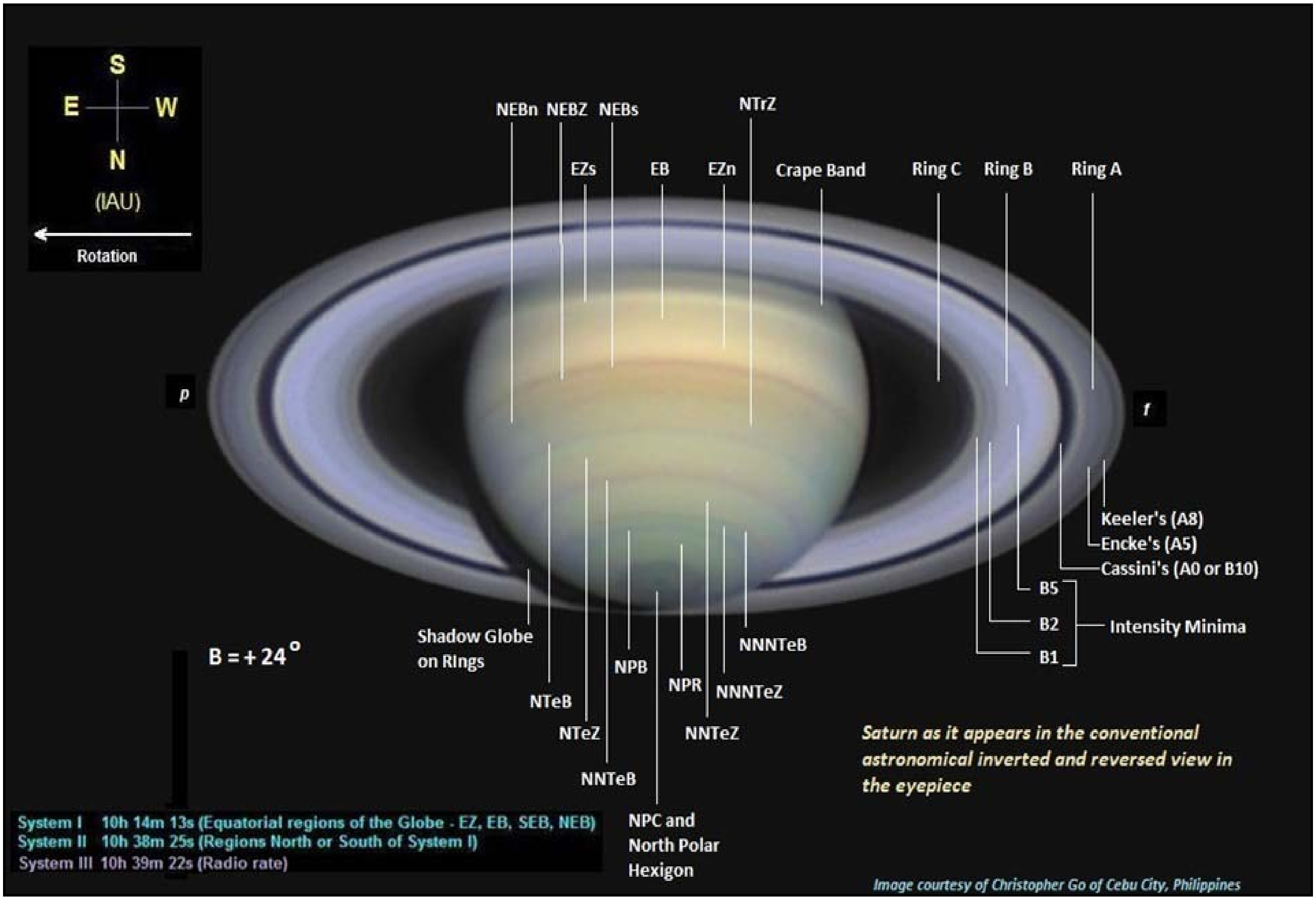


Figure 5. Saturn nomenclature, where A = Ring A, B = Band or Ring B or saturnicentric latitude of Earth, C = Ring C or Cap, E = Equatorial, f = following (celestial east), G = Globe, n = north component, N = North, p = preceding (celestial west), P = Polar, R = Ring(s) or Region, s = south component, S = South, Te = Temperate, Tr = Tropical, Z = Zone. The ring Ansae (not labeled) are the easternmost and westernmost protrusions of the Ring System. Note that "Gap" is also called "Division" or "Complex." South is at the top in this inverted view, similar to the orientation seen through an inverting telescope in Earth's Northern Hemisphere.

component brightness fluctuations over many apparitions. The ALPO Saturn Section is at all times happy to receive observations from novices, and the author is always delighted to offer assistance as one becomes acquainted with our programs.

The collection of 287 observations contributed to the ALPO Saturn Section during 2013-14 were used to prepare this report. Drawings, digital images, tables and graphs are included so readers can refer to them as they study the content of this report. As applicable, for drawings or images provided herein as examples of notable features or phenomena occurring within Saturn's belts and zones, contributors are identified in the text along with dates and times of those specific observations for easy reference back to the relevant tables that list instrumentation employed, seeing, transparency, CM data and so forth. In addition, captions associated with illustrations provide useful information.

The numerical value of **B** (the Saturnicentric latitude of the Earth referred to the ring plane) attained a maximum value of +22.7° during the 2013-14 apparition. Thus, opportunities for viewing the belts and zones and other phenomena of the planet's northern hemisphere have steadily improved each observing season with the Earth situated north of the rings as they increase their inclination toward our line of sight with maximum tilt of +27° coming in 2017 (the time of summer solstice in Saturn's northern hemisphere). Features of the southern hemisphere were primarily hidden by the rings as they crossed in front of the globe.

Minor fluctuations in intensity of Saturn's atmospheric features (see Table 3) may simply be due to the varying inclination of the planet's rotational axis relative to the Earth and Sun, although photometric work in past years suggests that small oscillations of about ±0.10 in the visual magnitude of Saturn likely happens over the span of a decade or so. Transient and longer-lasting atmospheric features seen or imaged in various belts and zones on the globe may also play a role in what appear to be subtle brightness variations. Regular photoelectric photometry of Saturn, in conjunction with carefully executed visual numerical relative intensity estimates, is strongly encouraged. The intensity scale routinely employed by Saturn observers is the standard ALPO Standard Numerical Relative Intensity Scale, where 0.0 denotes a total black condition (e.g., completely black shadow) and 10.0 is the maximum brightness of a feature or phenomenon (e.g., an unusually bright EZ or dazzling white spot). This numerical scale is normalized by setting the outer third of Ring B at a "standard" intensity of 8.0. The arithmetic sign of an intensity change is determined by subtracting a feature's 2012-13 intensity from its 2013-14 value. Suspected variances of ±0.10 mean intensity points are usually insignificant, while reported changes in intensity that do not equal or exceed roughly three times the standard error are probably not important.

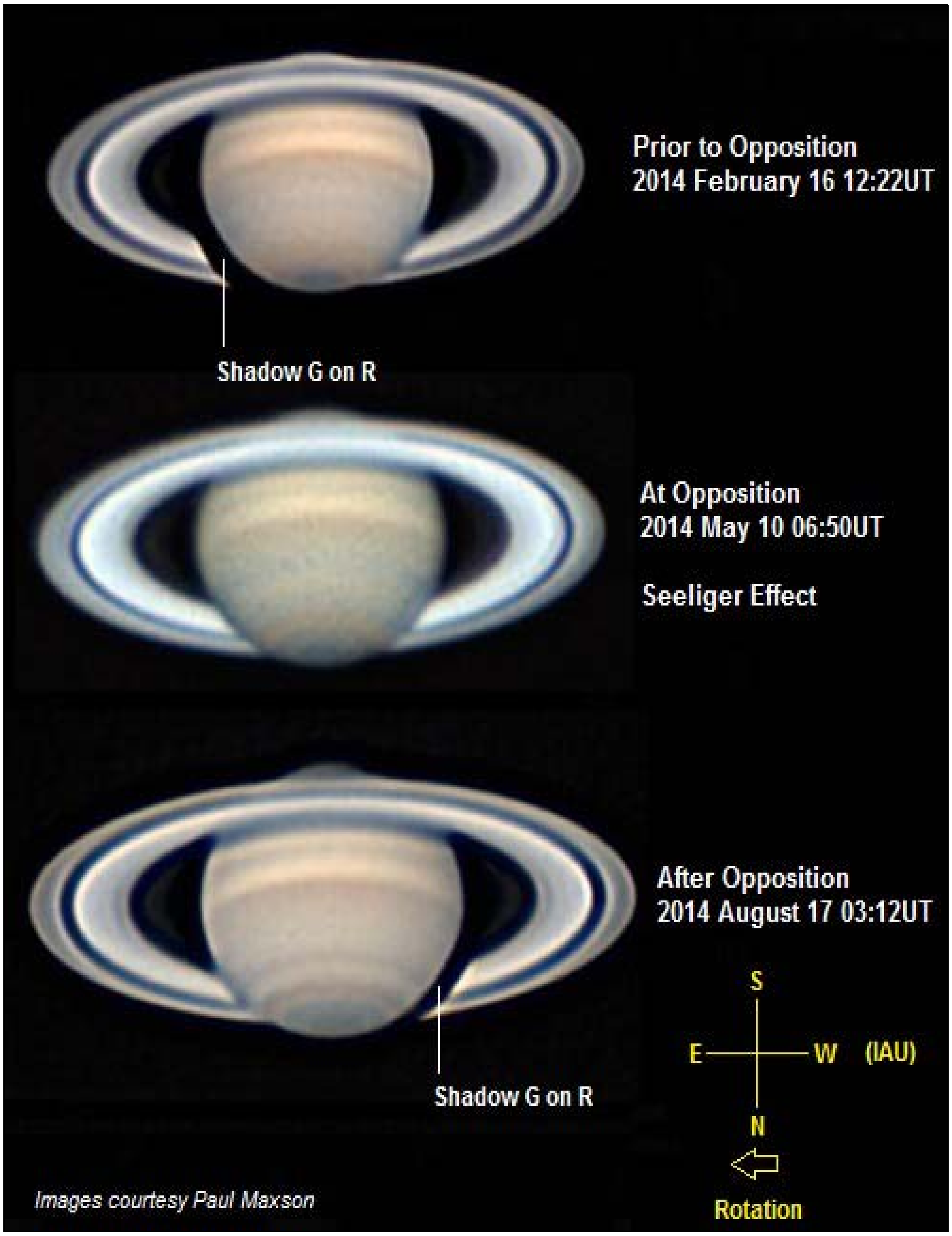


Figure 6. Three images digital images furnished by Paul Maxson on February 16, 2014 at 12:22 UT (before opposition), May 10, 2014 06:50 UT (at opposition), and August 17, 2014 at 03:12 UT (after opposition).

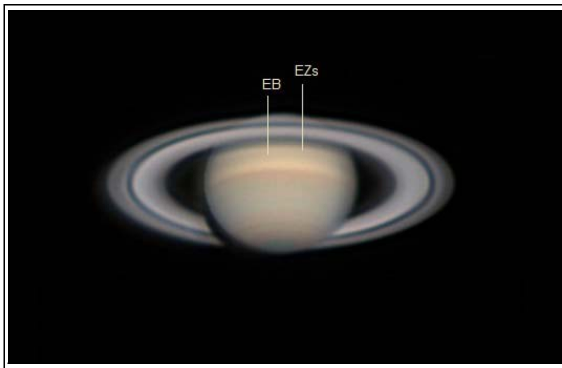
It is important to evaluate contributed digital images of Saturn captured with different apertures using systematic filter techniques to understand the level of detail seen and how such phenomena compares with impressions by visual observers of the globe and rings. Moreover, it remains worthwhile to establish any correlation with spacecraft imaging and results from professional observatories. In addition to routine visual studies, such as drawings and visual numerical relative intensity estimates, Saturn observers are asked to systematically image the planet every possible clear night if possible. This allows documentation of individual features on the globe and in the rings, their motion and morphology (including changes in intensity and hue), to facilitate comparisons with images taken by professional ground-based observatories and spacecraft monitoring Saturn at close range. Furthermore, comparing images taken over several apparitions for a given hemisphere of the planet's globe provides information on long-term seasonal changes suspected by observers using visual numerical relative intensity estimates. Images and systematic visual observations by amateurs are being relied upon for providing initial alerts of interesting large-scale features on Saturn

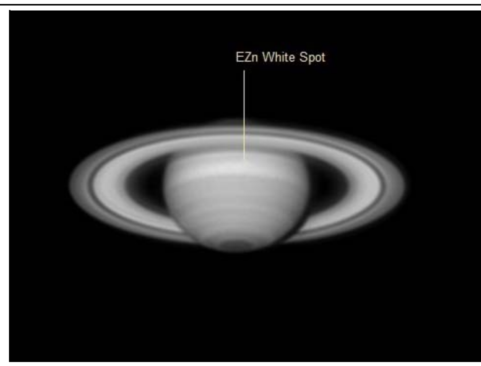
***General Caption Note for Illustrations 1-28. B** = saturnicentric latitude of the Earth; **B’** = saturnicentric latitude of the Sun; CMI, CMII and CMIII = central meridians in longitude Systems I, II and III; IL = integrated light; S = Seeing on the Standard ALPO Scale (from 0 = worst to 10 = perfect); Tr = Transparency (the limiting naked-eye stellar magnitude). Telescope types as in Table 2; feature abbreviations are as in Figure 5. In all figures, south is at the top and IAU east is to the left.*

t h

at professionals may not already know about but can subsequently examine with considerably larger and more specialized instrumentation.

Particles in Saturn's atmosphere reflect different wavelengths of light in very distinct ways, which causes some belts and zones to appear especially prominent, while others look very dark. Therefore, imaging the planet with a series of color filters may help shed light





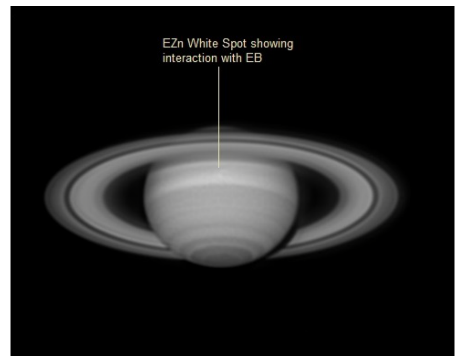


Illustration 001 (top left). 2014 February 06 18:48UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with RGB filters. S = 4.5, Tr = not specified. CMI = 203.0°, CMII = 48.3°, CMIII = 250.7°, B = +22.62°, B´ = +21.32°. EZs is noticeable just S of the EB and EZn.

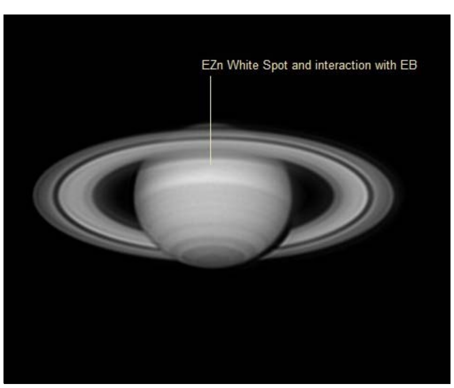
Illustration 002 (top center). 2014 July 21 08:52UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with 742nm IR filter. S = 5.0, Tr = not specified. CMI = 211.3°, CMII = 140.4°, CMIII = 144.3°, B = +21.07°, B´ = +22.58°. EZn white spot (appearing slightly elongated) is just W of the CM and very apparent at near-IR wavelengths in this image.

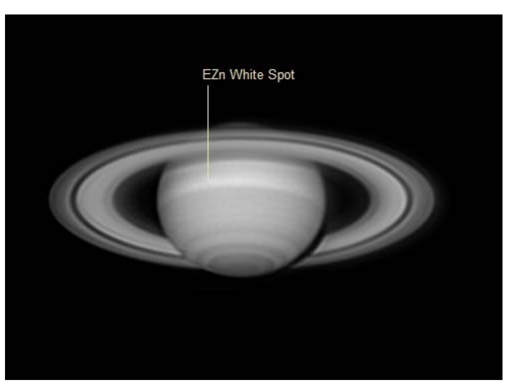
Illustration 003 (top right). 2014 August 21 09:13UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with Red filter. S = 5.0, Tr = not specified. CMI = 113.6°, CMII = 121.0°, CMIII = 87.6°, B = +21.42°, B´ = +22.00°. EZn white spot at CM seems elongated and internally multiple, interacting with N edge of the EB. It is more obvious in red light, but still noticeable at RGB and near-IR wavelengths.

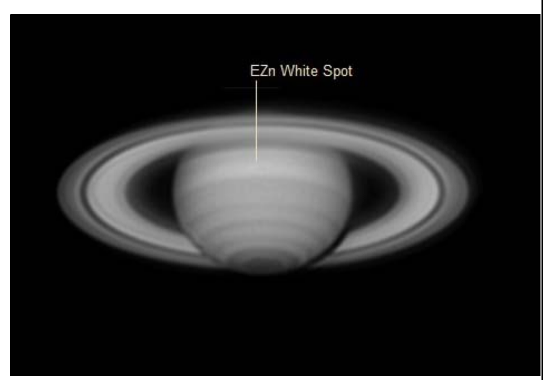
Illustration 004 (bottom left). 2014 August 24 08:45UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with Red filter. S = 6.0, Tr = not specified. CMI = 109.7°, CMII = 20.9°, CMIII = 343.8°, B = +21.47°, B´ = +22.82°. EZn white spot at CM at red wavelengths in good seeing; seemingly more diffuse, and still faintly showing involvement with EB.

Illustration 005 (bottom center). 2014 August 27 08:35UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with Red filter. S = 6.0, Tr = not specified. CMI = 116.4°, CMII = 290.8°, CMIII = 250.1°, B = +21.52°, B´ = +22.84°. EZn white spot at CM at red wavelengths in good seeing showing the spot W of the CM; there is suspicion that the spot may be fading slightly.

Illustration 006 (bottom right). 2014 September 26 09:26UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with 742nm IR filter. S = 4.5, Tr = not specified. CMI = 270.8°, CMII = 195.2°, CMIII = 118.3°, B = +22.22°, B´ = +23.05°. EZn white spot near the CM at near-IR wavelengths in less-than-favorable seeing conditions; the feature is fainter and fuzzier than it was a month before.







on the dynamics, structure and composition of its atmosphere. In the UV and IR regions of the electromagnetic spectrum, it is possible to determine additional properties as well as the sizes of aerosols present in different atmospheric layers not otherwise accessible at visual wavelengths, as well as useful data about the cloud-covered satellite Titan. UV wavelengths shorter than 320nm are effectively blocked by the Earth's stratospheric ozone (O_3), while CO_2 and H_2O-vapor molecules absorb in the IR region beyond 727nm. The human eye is insensitive to UV light short of 320nm and can detect only about 1.0% at 690nm and 0.01% at 750nm in the IR (beyond 750nm visual sensitivity is essentially zero). Although most of the reflected light from Saturn reaching terrestrial observers is in the form of visible light, some UV and IR wavelengths that lie on either side and in close proximity to the visual region penetrate to the Earth's surface, and imaging Saturn in these near-IR and near-UV bands has provided some remarkable results in the past. The effects of absorption and scattering of light by the planet's atmospheric gases and clouds at various heights and with different thicknesses are often evident. Indeed, such images sometimes show differential light absorption by particles with dissimilar hues intermixed with Saturn's white NH_3 clouds.

In the next few paragraphs, our discussion of features on Saturn's globe will proceed in the usual south-to-north order (traditional astronomical inverted and reversed view). For clarity, the relative positions of major belts and zones can be identified by referring to the nomenclature diagram shown in Figure 5. If no reference is made to a global feature in this report, observers did not report the area during the 2013-14 apparition. It has been customary in past Saturn apparition reports to compare the brightness and morphology of atmospheric features between observing seasons, and this practice continues as much as possible so readers are aware of very subtle, but nonetheless recognizable, variations that may be occurring seasonally on the planet.

Saturn’s Globe: The Southern Hemisphere

Saturn's southern hemisphere during 2013-14 was mostly hidden from our view except for a portion of the yellowish-white Equatorial Zone (EZs) just south of where the Equatorial Band (EB) cross the globe, and no visual numerical relative intensity estimates were submitted.

Equatorial Zone - Southern Half (EZs). Just northward of the where the rings cross the globe of Saturn, higher resolution images revealed a portion of the southern half of the Equatorial Zone (EZs) that appeared yellowish-white, and visual observers also furnished similar impressions of the EZs, but unfortunately offered no visual numerical relative intensity estimates during 2013-14 [refer to Illustration No. 001].

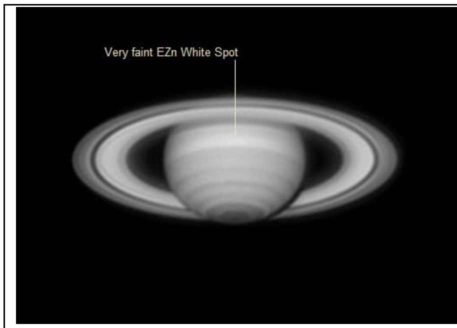
Saturn’s Globe: The Northern Hemisphere

Equatorial Band (EB). Visual numerical relative intensity estimates of the dusky Equatorial Band (EB) were not received during 2013-14, but the belt was depicted on several drawings in integrated light and generally noticeable on most digital images submitted during the observing season [refer to Illustration No. 001].

Equatorial Zone - Northern Half (EZn). With the numerical value of B ranging between the extremes of +21.0° and +22.7° in 2013-14, it was the northern half of the Equatorial Zone (EZn) that could be seen and imaged to greatest advantage. Based on very limited visual numerical relative intensity estimates and digital imaging, the bright yellowish-white Equatorial Zone (EZn) was slightly dimmer by -0.2 mean intensity points since 2012-13, but it was always the brightest zone on Saturn's globe in 2013-14. On July 21st at 08:52UT, Trevor Barry captured a very small slightly elongated white spot just west of the CM at near-IR (685nm) wavelengths in fair seeing, the first indication of discrete activity in the EZn during the 2013-14 apparition [refer to Illustration No. 002]. A subsequent image by the same observer between 08:39 UT and 09:48 UT on August 21st showed a similar feature resolved using RGB, red, near-IR (685nm) filters, displaying morphological structure (possibly multiple white spots clustered together). The location of this feature was roughly measured at saturnigraphic latitude +8.3°, with an apparent interaction with the N edge of the EB [refer to Illustration No. 003].

Trevor Barry again imaged the EZn white spot between 08:39 UT and 10:06 UT on August 24th using RGB and red filters (estimating its location at saturnigraphic latitude +9.1°), with the impression that the feature was enlarged longitudinally. On August 24 it also seemed more diffuse, not quite as bright as on August 21, but still showing some involvement with the EB [refer to Illustration No. 004]. A follow-up image of the diffuse EZn white spot was provided by the same observer on August 27 from 08:35 to 09:37 UT at RGB and red wavelengths at about saturnigraphic latitude +8.9° [refer to Illustration No. 005]. An image of the same bright EZn white spot near the CM on September 26 at 09:26 UT from Trevor Barry using a 742nm IR filter in poorer seeing, seemingly fainter and fuzzier (due to poorer seeing?) than in his images between August 21 and 27th [refer to Illustration No. 006]. Trevor Barry provided a calculated CMIII drift rate of +38.7° per day from July 21 through September 26 for the EZn white spot. He submitted an image of another less prominent EZn white spot on October 2 at 09:08 UT at 742nm IR wavelength [refer to Illustration No. 007], stating that it was very likely different from the brighter EZn white feature he tracked for nearly two months previously. There were no other specific accounts received of white spot activity in the EZn from other observers using imaging techniques during the observing season, nor were there any reports of such features by visual observers. Visual observers did offer comment that the EZn often slightly less prominent in 2013-14 than in 2012-13.

North Equatorial Belt (NEB). The rather broad and dull yellowish-brown NEB (considered as a whole feature and abbreviated as "NEBw") was frequently reported by visual observers and imaged regularly throughout the 2013-14 apparition. Visual observers reported the NEBw as a singular belt just as frequently as it was described as being separated into the NEBs and NEBn components with the NEBZ lying in between during most of the observing season. The NEBw, showing an insignificant dimmer appearance of only -0.18 mean intensity points since 2012-13, usually displayed a lighter-to-darker southward progression in intensity across its broad width, consistent also with its form on most digital images. Accompanying descriptive reports and visual numerical relative intensity estimates revealed that the dark grayish-brown NEBs was -0.68 mean intensity points darker than the grayish-



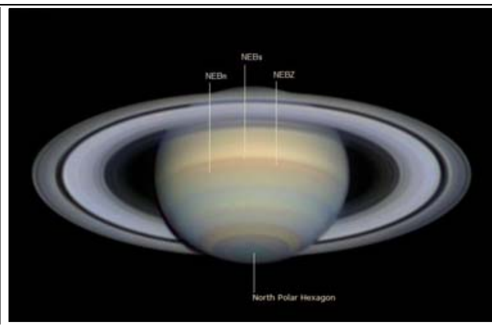


Illustration 007 (top left). 2014 October 2 09:36UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with 742nm IR filter. S = 5.0 Tr = not specified. CMI = 301.5°, CMII = 31.9°, CMIII = 307.7°, B = +22.38°, B´ = +23.09°. Very faint EZn white spot near CM in near-IR wavelength. Observer notes this feature not the same as the brighter one tracked between July and late September.

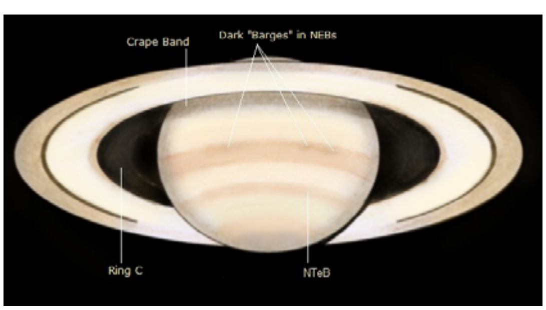
Illustration 008 (top center). 2014 April 18 06:25UT. Digital image by Damian Peach. 35.6 cm (14.0-in.) SCT with RGB filters. S and Tr not specified. CMI = 318.5°, CMII = 47.0°, CMIII = 164.4°, B = +22.15°, B´ = +21.87°. Detailed image depicts very narrow and dark NEBs, lighter more latitudinally diffuse NEBn, and narrow NEBZ in between. Notice also the North Polar Hexagon in this fine image.

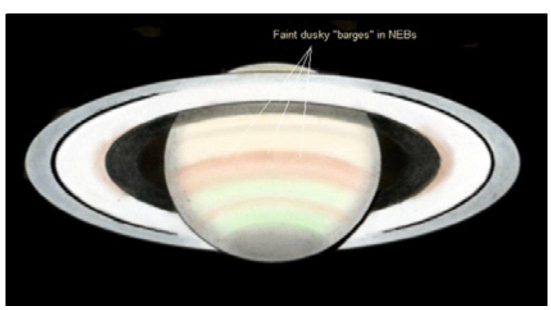
Illustration 009 (top right). 2014 May 18 01:12UT. Detailed sketch by Paul G. Abel. 20.3 cm (8.0 in.) NEW in Integrated Light (no filter) at 250X. S = 5.0 (interpolated), Tr (described as average but not numerically rated). CMI = 266.6°, CMII = 113.1°, CMIII = 194.6°, B = +21.61°, B´ = +22.10°. Impressive colorized drawing showing two elongated dusky “barges” within the narrow NEBs.

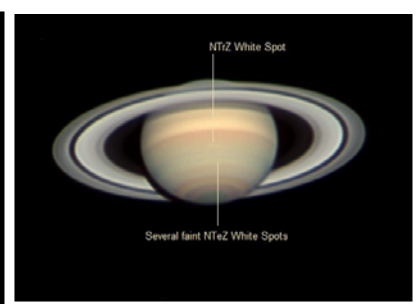
Illustration 010 (bottom left). 2014 May 31 22:34UT. Drawing by Paul G. Abel. 50.8 cm (20.0 in.) DALL in Integrated Light (no filter) at 230X. S = 6.0 (interpolated), Tr (described as average with some haze but not numerically rated). CMI = 114.9°, CMII = 232.7°, CMIII = 297.5°, B = +21.38°, B´ = +22.20°. Colorized drawing showing three dusky “barges” in the NEBs on either side of the CM as well as the NTeB across the globe. Ring C is seen at the ansae, and the Crape Band is visible as well.

Illustration 011 (bottom center). 2014 June 12 22 :52UT. Drawing by Paul G. Abel. 20.3 cm (8.0 in.) NEW in Integrated Light (no filter) at 167X. S = 6.0 (interpolated), Tr (described as average with some haze but not numerically rated). CMI = 177.4°, CMII = 267.2°, CMIII = 317.5°, B = +21.22°, B´ = +22.29°. Colorized drawing depicting three faint dusky “barges” in the NEBs across the globe.

Illustration 012 (bottom right). 2014 April 06 14:56UT. Digital image by Anthony Wesley. 36.8 cm (14.5 in.) NEW with RGB filters. S and Tr not specified. CMI = 205.4°, CMII = 310.0°, CMIII = 81.4°, B = +22.33°, B´ = +21.78°. Very faint NTrZ white spot nearly on the CM in good seeing.







brown NEBn, with a barely perceptible yellowish-gray NEBZ separating them. The darker and better-defined NEBs was also much narrower in width than the seemingly more latitudinally diffuse NEBn as described by visual observers and revealed in many of the best digital images during 2013-14 [refer to Illustration No. 008]. Although visual observers usually reported the NEBZ when the NEB was separated into components, there were no visual numerical relative intensity estimates submitted in 2013-14.

Paul G. Abel reported several very subtle dusky "barges" within the NEBs on May 18 at 01:12 UT [refer to Illustration No. 009], on May 31 at 22:34 UT [refer to Illustration No. 010], as well as depicted on yet another of his excellent drawings on June 12 at 22:52 UT [refer to Illustration No. 011]. There were no digital images submitted that clearly indicated any definitive activity within the NEB, and the features described by Paul G. Abel were the only discrete NEB phenomena reported by visual observers during the apparition.

North Tropical Zone (NTrZ). Visual numerical relative intensity estimates of this zone were unfortunately nonexistent other than a singular report that suggested that the light yellowish-white NTrZ was slightly brighter by a factor of +0.67 since 2012-13. The NTrZ was quite apparent on most images captured in good seeing conditions throughout the observing season and reported often in descriptive reports by visual observers. The first image of any discrete NTrZ white spot phenomena this apparition was received from Anthony Wesley on April 6 at 14:56 UT, depicting a very faint compact spot nearly on the CM [refer to Illustration No. 012]. On April 22 at 05:05 UT, Damian Peach provided a monochrome image of a similar tiny white spot between the W limb and the CM [refer to Illustration No. 013], and two days later on April 24, he captured with RGB filters what was apparently the same white spot just past the CM at 05:01 UT [refer to Illustration No. 014]. In consideration of the aforementioned NTrZ white spot activity during 2013-14 (and in several recent apparitions), it is very tempting to still interpret such features as gradually fading atmospheric "fossils" of the immense NTrZ storm of 2010-11. Because of the considerable latitudinal widening that transpired as the complex bright storm morphologically evolved with time and lingered throughout succeeding observing seasons, it proved difficult to clearly establish sharp northern and southern boundaries of the NTrZ occupying the region between saturnigraphic latitude +35° and +45° in the wake of the 2010-11 storm.

North Temperate Belt (NTeB). The grayish-brown NTeB was reported only sporadically by visual observers during 2013-14, and if the solitary visual numerical relative intensity estimate provided is of any relevance, the NTeB was perhaps slightly darker since 2012-13 (a difference of -0.4 mean intensity points). Visual drawings of the NTeB depicted the feature as a rather narrow linear feature across the globe of Saturn as sketched by Paul G. Abel on May 31 at 22:34 UT [refer to Illustration No. 010]. However, digital images of Saturn during the apparition showed the NTeB as a slightly wider belt in apparent contrast with visual impressions, such as the superb RGB image taken by Gary Walker on April 27 at 06:25 UT [refer to Illustration No. 015].

North Temperate Zone (NTeZ). Sadly, there were no visual numerical relative intensity estimates this apparition of the yellowish-gray NTeZ to evaluate any change in prominence of this zone since 2012-13. Nevertheless, the NTeZ was quite apparent on drawings submitted during the apparition and also on the majority of digital images contributed. Where the NTeZ was a bit more conspicuous than the NTrZ on most images. Bright spot activity in the NTeZ was reported during 2013-14 by several observers who routinely imaged Saturn. Marc Delcroix was the earliest ALPO Saturn observer to detect white spot activity in his image of March 9 at 4:12 UT, where he captured a string of small white spots across the globe in fair seeing in the NTeZ [refer to Illustration No. 016]. Anthony Wesley furnished a similar RGB image of faint white spots in this zone on April 6 at 14:56 UT [refer to Illustration No. 012]. Damian Peach imaged a white spot in the NTeZ at RGB wavelengths just beyond the CM on April 14 at 07:25 UT [refer to Illustration No. 017]. He also furnished impressive monochrome images of segmented white spots within the NTeZ on April 18 at 06:25 UT and April 22 at 05:05 UT [refer to Illustrations No. 018 and 013], as well as an RBG image showing NTeZ white spots on April 24 at 05:01 UT [refer to Illustration No. 014]. Continued imaging by observers during the apparition occasionally revealed white spots in the NTeZ, but after late April 2014, such activity seemed to wane.

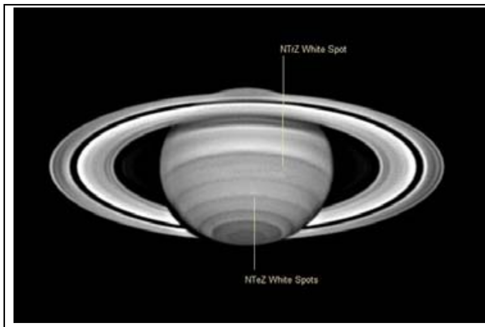
Beginning in mid-April, observers started detecting dark spots within the NTeZ, the initial report occurring on April 17 at 05:34 UT by Damian Peach of a diminutive dark feature near the CM in green light [refer to Illustration No. 019]. Trevor Barry imaged Saturn on May 23 at 13:52 UT, recording a small dark spot in the NTeZ with a red filter in good seeing [refer to Illustration No. 020], while his image taken in red light on July 26 at 09:17 UT clearly shows the NTeZ dark spot in excellent seeing conditions [refer to Illustration No. 021]. The fact that the recurring dark spot was still present as a compact discrete feature as the apparition progressed is illustrated by Trevor Barry's RGB image at 08:51 UT on August 19 [refer to Illustration No.

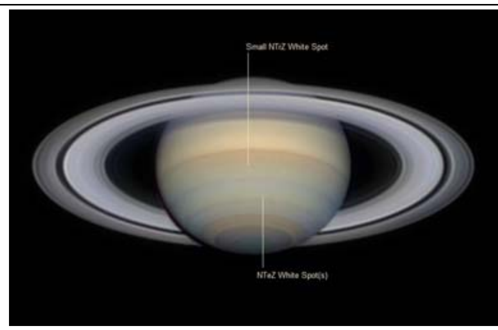
022] as does his image on October 1 at 09:10 UT in red light [refer to Illustration No. 023]. Visual observers did not report the small dark spot during the apparition.

North North Temperate Belt (NNTeB). The dull gray NNTeB was difficult to detect even on the best images taken in good seeing conditions in 2013-14, but Christopher Go's beautiful image of May 31 at 13:10 UT easily shows the narrow belt [refer to Illustration No. 024]. Visual observers did not report the NNTeB during the observing season.

North North Temperate Zone (NNTeZ). During 2013-14, the often-dull yellowish-gray NNTeZ was not reported visually, but was depicted on the best images taken with moderate-to-larger apertures during the observing season [refer to Illustration No. 024]. As far as activity in the region is concerned, on May 23 at 13:24 UT at 742nm (near-IR) wavelength, Trevor Barry imaged what appears to be three dark spots within the NNTeZ in good seeing [refer to Illustration No. 025]. There were no other reports of obvious features in the zone. Visual observers did not submit visual numerical intensity estimates of the NNTeZ during the 2012-13 apparition.

North Polar Region (NPR). Visual observers frequently reported the gray NPR, and it was evident on digital images contributed during the 2013-14 apparition. Visual numerical relative intensity estimates were few in number, but suggested only a trivial dimming of the NPR by -0.14 in mean intensity since 2012-13. The NPR was devoid of any recognizable activity by visual observers





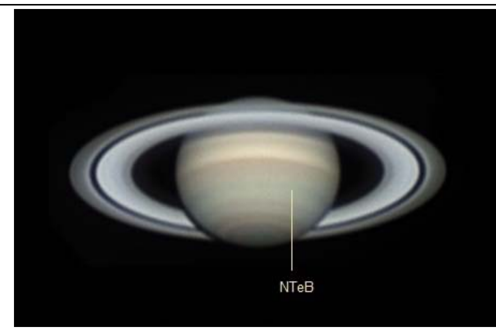


Illustration 013 (top left). 2014 April 22 05:05UT. Digital image by Damian Peach. 35.6 cm (14.0-in.) SCT with monochrome filter. S and Tr not specified. CMI = 49.2°, CMII = 10.3°, CMIII = 122.9°, B = +22.08°, B´ = +21.90°. Small compact white spot in the NTrZ and a string of white spots of variable brightness in the NTeZ.

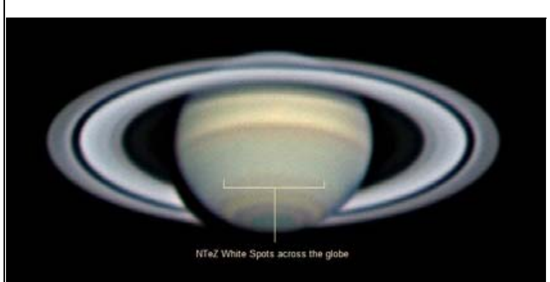
Illustration 014 (top center). 2014 April 24 05:01UT Digital image by Damian Peach. 35.6 cm (14.0-in.) SCT with RGB filters. S and Tr not specified. CMI = 295.7°, CMII = 192.2°, CMIII = 302.5°, B = +22.04°, B´ = +21.92°. Small NTrZ White Spot just E of CM and NTeZ white spot(s) about to cross CM.

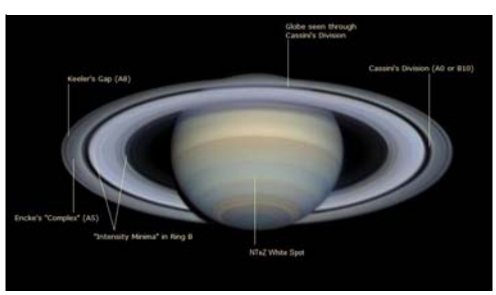
Illustration 015 (top right). 2014 April 27 06:25UT. Digital image by Gary Walker. 25.4 cm (10.0 in.) REF with RGB filters. S = 7.0, Tr = 4.0. CMI = 358.1°, CMII = 155.9°, CMIII = 262.4°, B = +21.99°, B´ = +21.94°. Greyish-brown NTeB is apparent across the globe in this detailed image.

Illustration 016 (bottom left). 2014 March 09 04:12UT. Digital image by Marc Delcroix. 106.0 cm (41.7 in.) CAS with RGB filters. S and Tr not specified. CMI = 304.6°, CMII = 248.1°, CMIII = 53.9°, B = +22.62°, B´ = +21.56°. Series of five or more small white spots are strung out across the globe within the NTeZ.

Illustration 017 (bottom center). 2014 April 14 07:25UT. Digital image by Damian Peach. 35.6 cm (14.0-in.) SCT with RGB filters. S and Tr not specified. CMI = 216.1°, CMII = 72.4°, CMIII = 194.6°, B = +22.21°, B´ = +21.84°. NTeZ white spot is near the CM in this marvelous high-resolution image of Saturn. Notice also Keeler's Gap (A8), Encke's "Complex" or Gap (A5), Cassini's Division (A0 or B10), and various "intensity minima" in Ring B. The globe of Saturn is discernable behind Cassini's Division where it crosses the globe.

Illustration 018 (bottom right). 2014 April 18 06:25UT. Digital image by Damian Peach. 35.6 cm (14.0-in.) SCT with monochrome filters. S and Tr not specified. CMI = 318.5°, CMII = 47.0°, CMIII = 164.4°, B = +22.15°, B´ = +21.87°. Detailed monochrome image depicting multiple





and those imaging Saturn during the observing season. Although visual observers did not report the NPB (North Polar Belt) in 2013-14, this narrow feature was usually recognizable on most detailed images encircling the NPR as in the image of May 31 at 13:10 UT by Christopher Go [refer to Illustration No. 024]. The always intriguing North Polar hexagon was easily recognizable on many of the best images this apparition [refer to Illustration No. 008].

Shadow of the Globe on the Rings (Sh G on R). The Sh G on R was visible to observers as a geometrically regular black shadow on either side of opposition during 2013-14. Any apparent variation of this shadow from a totally black intensity (0.0) during a given observing season is purely a consequence of bad seeing conditions or the presence of extraneous light. Digital images revealed this feature as completely black. Readers are reminded that the globe of Saturn casts a shadow on the ring system to the left (or IAU East) prior to opposition, to the right (or IAU West) after opposition, and on neither side precisely at opposition (no shadow). This is illustrated in Figure 6, which shows digital images furnished by Paul Maxson on February 26, 2014 at 12:22 UT (before opposition), May 10, 2014 at 06:50 UT (at opposition) and August 17, 2014 03:12 UT (after opposition).

Latitude Estimates of Features on the Globe. Observers did not submit latitude estimates of features on Saturn's globe during 2012-13. Readers are encouraged to try this simple visual technique developed by Walter Haas over 60 years ago to estimate latitudes. It merely involves determining as accurately as possible the fraction of the polar semidiameter of Saturn's globe subtended on the central meridian (CM) between the limb and the feature whose latitude is desired. As a control on the accuracy of this method, observers should include in their estimates the position on the CM of the projected ring edges and the shadow of the rings. The actual latitudes can then be calculated from the known values of **B** and **B'** and the dimensions of the rings, but this test cannot be effectively applied when **B** and **B'** are near their maximum attained numerical values. Experienced observers have used this visual convenient procedure for many years with very reliable results, especially since filar micrometers are virtually non-existent, and if available, they tend to be very expensive, not to mention sometimes tedious to use. A detailed description of the technique can be found in the author's book entitled *Saturn and How To Observe It*, published by Springer and available from booksellers worldwide.

Saturn's Ring System

This section addresses visual studies of Saturn's ring system with the accustomed comparison of mean intensity data between apparitions, as well as interpretations of digital images of the rings contributed during 2013-14. With the ring tilt toward Earth in 2013-14 increasing to as much as +22.7°, the major ring components were much easier to see and image as the rings continued to progress toward their maximum inclination of +27° during the future 2016-17 apparition.

Ring A. Most visual observers agreed that the dull greyish-white Ring A (taken as a whole) was faintly dimmer in 2013-14 than in 2012-13 based on visual numerical relative intensity estimates (by a difference of merely -0.22 mean intensity points). Visual observers described Ring A as being largely homogeneous as opposed to being subdivided into inner and outer halves, but digital images of Saturn in 2013-14 usually revealed inner and outer halves of Ring A, with the inner half slightly brighter than the outer half. Visual observers sometimes reported the very dark gray Encke's division (A5) in 2013-14 when the rings were near their maximum tilt but offered no visual numerical relative intensity estimates, while many of the best images revealed A5 near the ansae. There were hints of Keeler's gap (A8) on some images, but it was not described by visual observers [refer to Illustration No. 017].

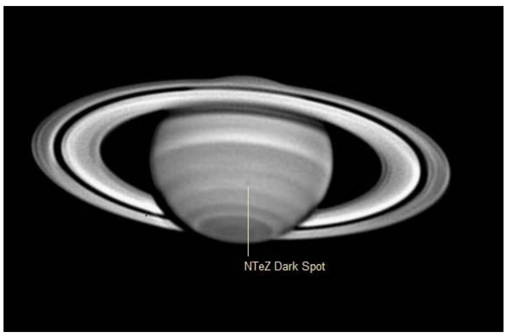
Ring B. The outer third of Ring B is the traditional standard of reference for the ALPO Saturn Visual Numerical Relative Intensity Scale, with an assigned value of 8.0. Under circumstances of greater ring tilt during the 2013-14 apparition, visual observers reported that the outer third of Ring B appeared brilliant white with no variation in intensity, and compared with other ring components and atmospheric phenomena of Saturn's globe, it was always the brightest intrinsic feature. The inner two-thirds of Ring B during this apparition, described as yellowish-white and uniform in intensity, displayed a somewhat duller intensity by a mean factor of -0.57 compared with 2012-13. Digital images confirmed most visual impressions during this observing season, with those of the highest resolution in good seeing revealing several "intensity minima" across the breadth of Ring B [refer to Illustration No. 017].

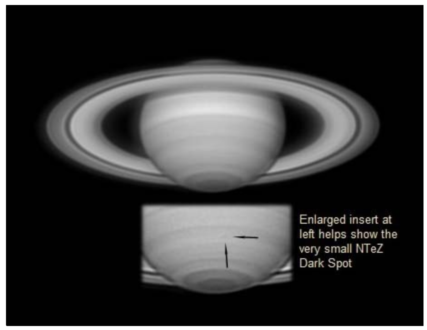
Cassini's Division (A0 or B10). Visual observers usually reported Cassini's Division (A0 or B10) in 2013-14 but no visual numerical relative intensity estimates were contributed. It was described as a black gap at both ansae and repeatedly traceable all the way around Saturn's ring system by visual observers (except, of course, where the globe blocked views of the rings). This was also true for most of the high-resolution images submitted [refer to Illustration No. 017]. While a black Cassini's Division was obvious on most digital images received during the 2013-14 observing season, any assumed deviation from a totally black intensity for

Cassini's Division was a consequence of poor seeing, scattered light, or insufficient aperture. The globe could be seen through Cassini's division (A0 or B10) in a quite a number of the best images submitted this observing season [refer to Illustration No. 017].

Ring C. The very dark gray Ring C was revealed at the ansae on most digital images during 2013-14 and shown on drawings made by visual observers [refer to Illustrations No. 026 and 010]. A limited number of visual numerical relative intensity estimates this apparition suggested that Ring C at the ansae was duskier by -0.21 mean intensity points than it appeared in 2012-13. The Crape Band (merely Ring C in front of the globe of Saturn) was reported by visual observers, appearing dull gray with uniform intensity, and lighter since 2012-13 by +0.40 intensity points [refer to Illustration No. 010]. The Crape Band was routinely detectable on digital images [refer to Illustration No. 026].

Opposition Effect. The Seeliger "opposition effect" was reported by a handful of observers on opposition date (May 10, 2014), which is a readily noticeable brightening of Saturn's ring system during a very brief interval on either side of opposition when the phase angle between Sun, Saturn and the Earth is ≤0.3°. This ring brightening is due to





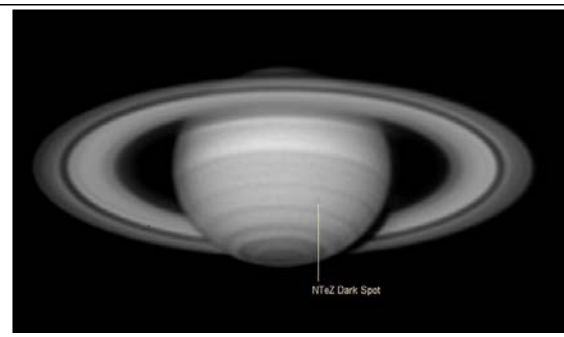


Illustration 019 (top left). 2014 April 17 05:34UT. Digital image by Damian Peach. 35.6 cm (14.0-in.) SCT with monochrome filters. S and Tr not specified. CMI = 164.2°, CMII = 286.1°, CMIII = 44.8°, B = +22.16°, B´ = +21.86°. Monochrome image exhibiting the very small dark condensation or spot within the NTeZ.

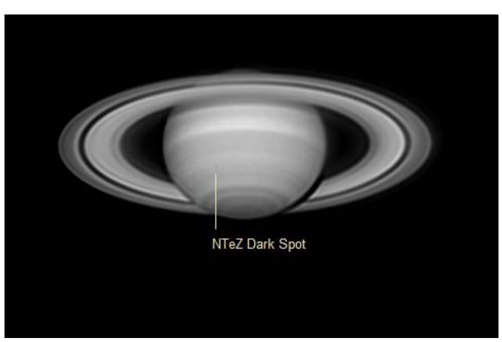
Illustration 020 (top center). 2014 May 23 13:52UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with red filter. S = 6.5 Tr = not specified. CMI = 18.4°, CMII = 14.0°, CMIII = 87.7°, B = +21.50°, B´ = +22.15°. Very small dark spot in the NTeZ approaching the CM is barely detectable in this image (enlargement insert helps emphasize location of the spot).

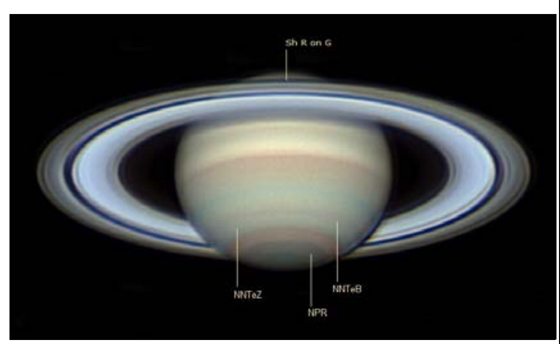
Illustration 021 (top right). 2014 July 26 09:17UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with red filter. S = 7.5 Tr = not specified. CMI = 127.0°, CMII = 254.1°, CMIII = 251.9°, B = +21.10°, B´ = +22.61°. The recurring small dark spot in the NTeZ is easier to detect in this image headed toward the CM.

Illustration 022 (bottom left). 2014 August 19 08:51UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with RGB filters. S = 4.5 Tr = not specified. CMI = 212.4°, CMII = 284.9°, CMIII = 253.8°, B = +21.30°, B´ = +22.78. The recurring and still compact small dark spot in the NTeZ is marginally visible in this image E of the CM.

Illustration 023 (bottom center). 2014 October 01 09:10UT Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with red filter. S = 5.5 Tr = not specified. CMI = 162.1°, CMII = 285.4°, CMIII = 202.5°, B = +22.35°, B´ = +23.08°. The small dark spot continues to remain visible in the NTeZ as the apparition progresses between the CM and preceding (*p*) limb.

Illustration 024 (bottom right). 2014 May 31 13:10UT. Digital image by Christopher Go. 35.6 cm (14.0 in.) SCT with RGB + IR blocking filter. S = 7.0, Tr = 4.0. CMI = 144.2°, CMII = 274.7°, CMIII = 339.9°, B = +21.39°, B´ = +22.20°. The dull gray NNTeB and yellowish-gray NNTeZ are depicted in this high resolution image. The gray NPR is also obvious. Notice that the Shadow of the Rings on the Globe (Sh R on G) is projected toward the S and seen beyond the outer edge of Ring A where it crosses the globe.





coherent back scattering of sunlight by µ-sized icy particles that make up the rings, scattering light far more efficiently than the particles of Saturn's atmosphere. Paul Maxson was among several observers whose images depicted this brightening of the rings during 2013-14, exemplified in his image at opposition on May 10 at 06:50 UT [refer to Illustration No. 027].

Shadow of the Rings on the Globe (Sh R on G). This shadow in 2013-14 was described as a completely black feature most of the time where the rings crossed Saturn's globe. Those very few instances when the shadow appeared as grayish-black, a departure from an overall black (0.0) intensity, occurred for the same reason as previously noted in our discussion regarding the Sh G on R. When **B** and **B'** are both positive, and the value of **B** is greater than that of **B'**, the ring shadow (Sh R on G) is to the north of the projected rings, which happened prior to May 3, 2014 [refer to Illustration No. 028]. When **B** and **B'** are both positive, and the value of **B** is less than of **B'**, the shadow of the rings on the globe (Sh R on G) is cast to their south, circumstances that occurred starting May 4, 2014 through October 8, 2014 (the final observation received for the apparition) [refer to Illustration No. 024].

Terby White Spot (TWS). The TWS is an apparent brightening of the rings immediately adjacent to the Sh G on R. There were only a few times when visual observers noticed this feature during 2013-14. It is an artificial contrast effect and not a real feature of Saturn's rings, but it is helpful to try to find any correlation that might exist between the visual numerical relative intensity of the TWS and the varying tilt of the rings, including its brightness and visibility using variable-density polarizers, color filters and digital images.

Bicolored Aspect of the Rings and Azimuthal Brightness Asymmetries. The bicolored aspect of the rings is an observed difference in coloration between the East and West ansae (IAU system) when systematically compared with alternating W47 (where W denotes the Wratten filter series), W38, or W80A (all blue filters) and W25 or W23A (red filters). There were no reports of this phenomenon in 2013-14, although in recent years observers have been systematically attempting to document the presence of the bicolored aspect of the rings using digital imagers. In the past, there have been rare instances when the phenomenon was allegedly photographed, and of particular importance would be images of the bicolored aspect at the same time it is sighted visually, especially when it occurs independent of similar effects on the globe of Saturn (which would be expected if atmospheric dispersion were a contributing factor). Such simultaneous visual observations cannot be stressed enough so that more objective confirmation of the bicolored aspect of the rings can occur.

Professional astronomers are well-acquainted with Earth-based sightings of azimuthal variations in the rings (initially confirmed by Voyager spacecraft), which probably is a consequence of light-scattering by denser-than-average clumps of particles orbiting in Ring A. ALPO Saturn observers are encouraged to try to image any azimuthal brightness asymmetries in Ring A, preferably at the same date that visual observers report it.

The Satellites of Saturn

Many of the planet's satellites show tiny fluctuations in visual magnitude as a result of their varying orbital positions relative to the planet and due to asymmetries in distribution of surface markings on a few. Despite close proximity sensing by spacecraft, the true nature and extent of all of the observed satellite brightness variations is not completely understood and merits further investigation.

Visual Magnitude Estimates and Photometry. ALPO Saturn Section observers in 2013-14 submitted no systematic visual estimates of Saturn's satellites employing recommended techniques by the ALPO Saturn Section. Even though photometry has largely replaced visual magnitude estimates of Saturn's moons, visual observers should still try to establish the comparative brightness of a satellite relative to reference stars of calibrated brightness when the planet passes through a field of stars that have precisely known magnitudes. To do this, observers need to employ a good star atlas that goes faint enough and an accompanying star catalogue that lists reliable magnitude values. A number of excellent computer star atlases exist that facilitate precise plots of Saturn's path against background stars for comparative magnitude estimates.

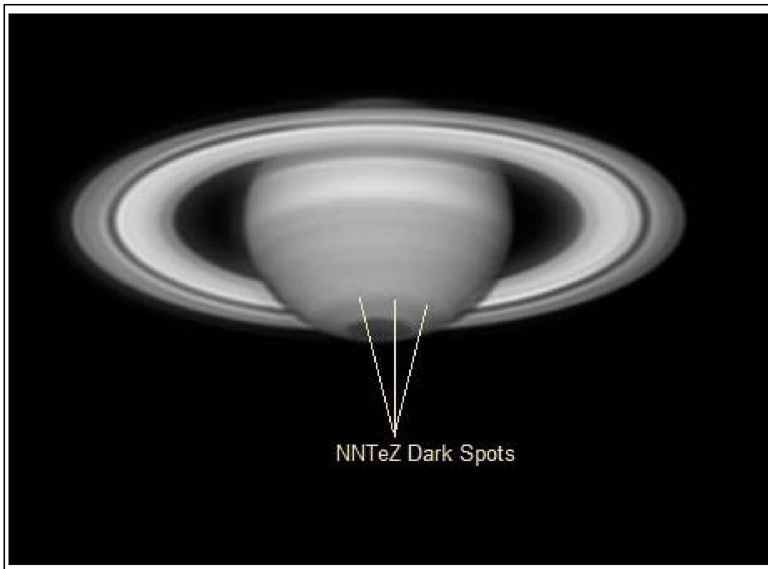
The methodology of visually estimating satellite magnitudes is simple. It starts with selection of at least two stars with well-established magnitudes and those that have about the same color and brightness as the satellite. One of the stars chosen should be slightly fainter and the other a little brighter than the satellite so that the difference in brightness between the stars is roughly 1.0 magnitude. This makes it easy to divide the brightness difference between the two comparison stars into equal magnitude steps of 0.1. To estimate the visual magnitude of the satellite, simply place it along the scale between the fainter and brighter comparison stars. In the absence of suitable reference stars, however, a last resort alternative is to use Saturn's brightest satellite, Titan, at visual magnitude 8.4. It is known to exhibit only subtle brightness fluctuations over time compared with the other bright satellites of Saturn that have measured amplitudes.

Some observers have begun using digital imagers with adequate sensitivity to capture the satellites of Saturn together with nearby comparison stars, thereby providing a permanent record to accompany visual magnitude estimates as described above. Images of the positions of satellites relative to Saturn on a given date and time are worthwhile for crosschecking against ephemeris predictions of their locations and identities. It is important to realize, however, that the brightness of satellites and comparison stars on digital images will not necessarily be the same as visual impressions because the peak wavelength response of the CCD chip is typically different from that of the eye. Observers who have photoelectric photometers may also contribute measurements of Saturn's satellites, but they are notoriously difficult to measure owing to their faintness compared with the planet itself. Rather sophisticated techniques are required to correct for scattered light surrounding Saturn and its rings.

Spectroscopy of Titan. Since 1999, observers have been urged to attempt spectroscopy of Titan whenever possible as part of a cooperative professional-amateur project. Although Titan has been studied by the Hubble Space Telescope (HST), very large Earth-based instruments, and at close range the ongoing Cassini-Huygens mission, opportunities continue for amateurs to contribute systematic observations using appropriate instrumentation. Thanks to the Cassini-Huygens mission starting in 2004 (and continuing until at least 2017), we now know that Titan is a very dynamic world with transient and long-term variations. From wavelengths of 300nm to 600nm, Titan's hue is dominated by a reddish methane (CH4) atmospheric haze, and beyond 600nm, deeper CH4 absorption bands appear in its spectrum. Between these CH4 wavelengths are “portals” to Titan's lower atmosphere and surface, so regular monitoring in these regions with photometers or spectrophotometers is a useful complement to professional work. Long-term studies of Titan's brightness from one apparition to the next is meaningful in helping shed light on Titan's known seasonal variations. Observers with suitable equipment are being asked to participate in these professional-amateur projects, and further details can be found on the Saturn page of the ALPO website at http://www.alpo-astronomy.org/ as well as directly from the ALPO Saturn Section.

Simultaneous Observations

Simultaneous observations, or studies of Saturn by individuals working independently of one another at the same time and on the same date, offer unparalleled chances verification of ill-defined or traditionally controversial phenomena. The ALPO Saturn Section has organized a simultaneous observing team so that several individuals in reasonable proximity to each another can maximize the opportunities for viewing and imaging Saturn at the same time using similar equipment and methodology. Joint efforts like this significantly reinforce the level of



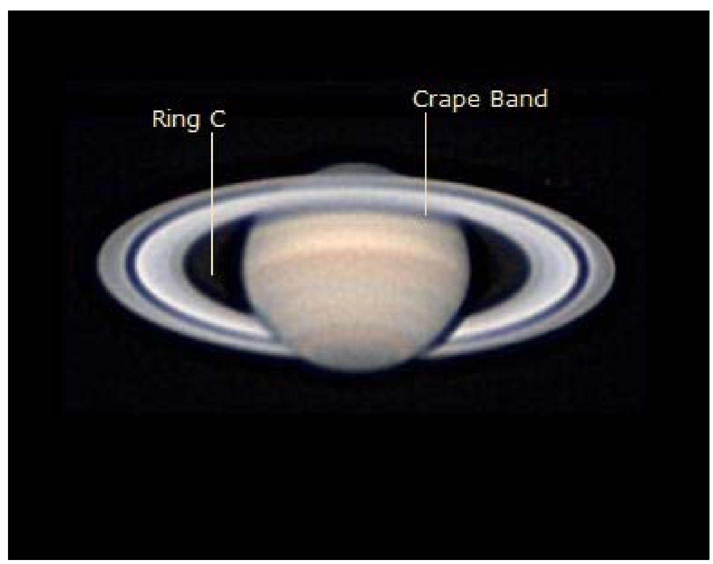


Illustration 025 (left). 2014 May 23 13:48UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with 742nm IR filter. S = 6.5 Tr = not specified. CMI = 251.7°, CMII = 279.7°, CMIII = 354.5°, B = +21.52°, B´ = +22.14°. There are at least three tiny dark spots within the NNTeZ apparent at near-IR wavelength.

Illustration 026 (right). 2014 June 14 04:35UT. Digital image by Paul Maxson. 25.0 cm. (9.8 in.) DALL with RGB filters. S and Tr not specified. CMI = 142.8°, CMII = 192.6°, CMIII = 241.4°, B = +21.21°, B´ = +22.30°. Ring C is visible at the ansae with the Crape Band seen where the rings cross Saturn’s globe.

confidence in the data submitted for each apparition. Some examples of such observations of Saturn during this apparition were cited earlier in this report. In forthcoming apparitions, such continued valuable work is strongly encouraged.

Pro-Am Opportunities

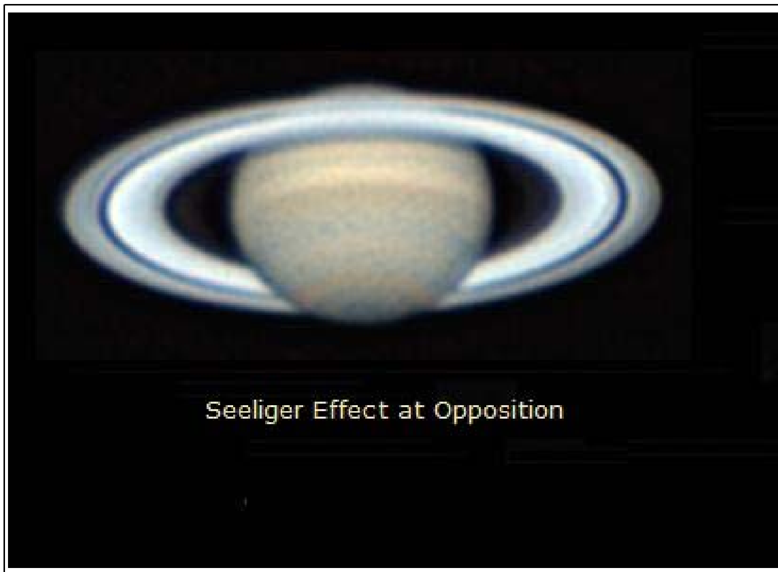
Our involvement in professional-amateur (Pro-Am) projects continued in 2013-14 in support of the Cassini mission with ALPO observers submitting images of discrete phenomena sighted or imaged on the globe of Saturn. Readers of this Journal are likely aware of the collaborative efforts of amateurs and professionals in keeping track of the dynamic, brilliant NTrZ white storm raging on Saturn during the 2010-11 observing season. Dating back to when Cassini began observing Saturn at close range a decade ago (in April 2004), digital images at wavelengths ranging from 400nm to 1µ have been actively sought by the professional community from amateurs and remains a project of high importance. In addition, more advanced observers should utilize classical broadband filters (e.g., Johnson system: B, V, R and I) with apertures upwards of 30.5 cm (12.0 in.) or larger, while also imaging through an 890-nm narrow band CH_4 (methane) filter.

So, to maintain our Pro-Am cooperation with the Cassini team, ALPO observers have been asked to continue to systematically patrol the planet every clear night for individual features, keeping track of their motions and morphology. Such reports provide input about interesting large-scale targets for on-board Cassini spacecraft imaging systems to include in close-up surveillance as the mission endures well into 2017. Note that visual observers with apertures ranging upwards from about 15.2 cm (6.0 in.) can play a very meaningful role by making routine visual numerical relative intensity estimates and recording suspected variations in belt and zone reflectivities (i.e., intensity) and color. The Cassini team combines ALPO Saturn Section images with data from the Hubble Space Telescope and from other professional ground-based observatories for immediate and future study.

As a means of facilitating regular Pro-Am observational cooperation, readers are asked to contact the ALPO Saturn Section with any questions as to how they can share their observational reports, drawings and images of Saturn and its satellites with the professional community. The author is always happy to offer guidance to novices, as well as observers that are more experienced. A meaningful resource for learning how to observe and record data on Saturn is the ALPO Lunar & Planetary Training Program, and it is recommended that beginners take advantage of this valuable educational resource. [Editor's Note: For more information, either e-mail Tim Robertson at cometman@cometman.net or contact him via regular mail at ALPO Lunar & Planetary Training Program, 195 Tierra Rejada, #148, Simi Valley, California 93065.]

Conclusions

Based on a comparatively small number of visual numerical relative intensity estimates arriving during 2013-14, with the exception of the North Tropical Zone (NTrZ) and the Crape Band, all other



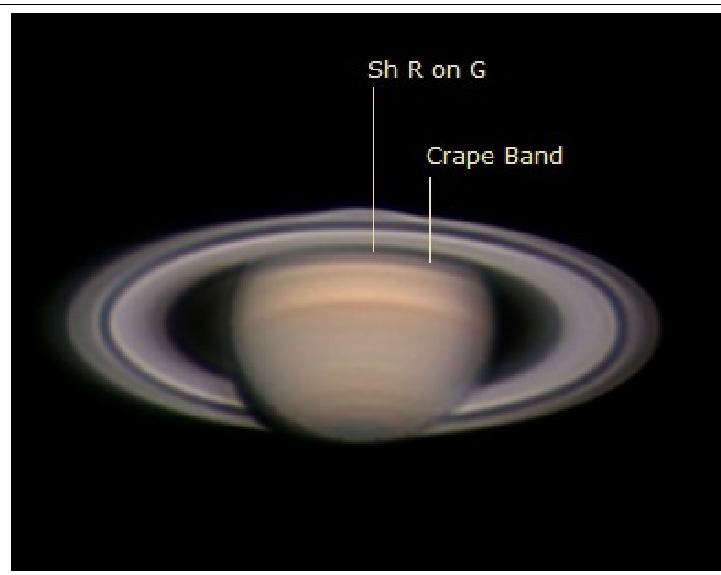


Illustration 027 (left). 2014 May 10 06:50UT. Digital image by Paul Maxson. 25.0 cm. (9.8 in.) DALL with RGB filters. S and Tr not specified. CMI = 189.8°, CMII = 287.1°, CMIII = 18.0°, B = +21.75°, B´ = +22.04°. The Seeliger Effect is quite apparent in Ring B in this image taken on opposition date.

Illustration 028 (right). 2014 January 26 18:19UT. Digital image by Trevor Barry. 40.6 cm (16.0 in.) NEW with RGB filters. S = 5.0 Tr = not specified. CMI = 258.4°, CMII = 99.7°, CMIII = 315.4°, B = +22.53°, B´ = +21.23°. The Shadow of the Rings on the Globe (Sh G on R) is seen projected N of where the rings cross the planet's globe. The Crape Band is also shown.

features of Saturn's globe exhibited a duskier appearance in overall brightness compared with the immediately preceding apparition. Saturn's southern hemisphere during 2013-14 was mostly blocked from our view by the rings with the exception of the yellowish-white Equatorial Zone (EZs) just to the south of where the Equatorial Band (EB) crossed the globe. Immediately southward of the rings, a few observers imaged a thin sliver of the diffuse northernmost edge of the dull gray South Polar Region (SPR).

With regard to activity on Saturn's globe during 2013-14, fossil remnants of the massive North Tropical Zone (NTrZ) storm of 2010-11 may have contributed to the appearance of several white spots seen and imaged in the region between Saturnigraphic latitude +35° and +45°. Imaging during 2013-14 also revealed diffuse bright areas within the North Temperate Zone (NTeZ), plus white spots in the EZn (Equatorial Zone, northern half). The repetitive appearance of a dark condensation in the North Temperate Zone (NTeZ) was captured on images during 2013-14, plus a less conspicuous dark spot in the North North Temperate Zone (NNTeZ). Observers also imaged the amazing hexagonal feature located at Saturn's North Pole frequently at different wavelengths.

ALPO observers worldwide continued their regular worldwide day-to-day coverage of Saturn during 2013-14 seeking discrete phenomena that may suddenly appear, with all significant data passed on to the Cassini team just as in previous apparitions. Thus, Pro-Am cooperation was in good shape this apparition, and keeping Saturn under scrutiny remains our goal for upcoming observing seasons.

Saturn's Ring System, apart from routine visual observations and digital images showing Cassini's (A0 or B10), Encke's (A5) and possibly Keeler's (A8) divisions, a handful of less noticeable intensity minima at different locations across the breadth of Ring B were perceived on many digital images and occasionally suspected by visual observers. Although observers used standard procedures for trying to confirm any bi-colored aspect of the rings during the 2013-14 apparition, there were no reports of the phenomenon by visual observers, and its presence on digital images was not noticeable.

Digital imaging, which now occurs as routinely as visual studies of Saturn, frequently divulges minute detail on the globe and in the rings below the normal visual threshold. With a combination of both observational methods, opportunities markedly increase for detecting changes on Saturn during any given apparition. Because of their sensitivity, digital imagers help detect outbursts of activity that visual observers can ultimately try to study with their telescopes. This helps establish limits of visibility of discrete features in integrated light (no filter) and at various wavelengths.

With regard to Saturn's satellites, during the 2013-14 apparition observers did not submit magnitude estimates.

Acknowledgements

The author expresses his sincere appreciation to all of the dedicated observers mentioned in this report for their submitted drawings, digital images, descriptive reports, simultaneous observations and visual numerical relative intensity estimates during the 2013-14 observing season.

Such routine systematic observational work enriches our endeavors and it strengthens Pro-Am collaboration and benefits us as we try to gain a better understanding of Saturn as a planet. Observers everywhere are encouraged to join us in our activities in upcoming apparitions.

References

Alexander, A.F. O'D. (1962). *The Planet Saturn*. London: Faber and Faber. http://www.amazon.com/planet-Saturn-history-observation-discovery/dp/B0006AY82U

Benton, J.L., Jr. (2005). *Saturn and How to Observe It*. London: Springer-Verlag. http://www.amazon.com/Saturn-Observe-Astronomers-Observing-Guides/dp/1852338873/ref=sr_1_1/105-9507435-7968466?ie=UTF8&s=books&qid=1183915123&sr=1-1

________ (1996). *Visual Observations of the Planet Saturn: Theory and Methods (The Saturn Handbook)*. Savannah, GA: Review Publishing Company, 1996 (8th Revised Edition - now available also in pdf from the author).

___________ (2014). "ALPO Observations of Saturn During the 2010-2011 Apparition," *Journal of the Assn. of Lunar & Planetary Observers*. Vol. 56, No. 2 (Spring), 2014, pp. 31-66. http://www.alpo-astronomy.org/djalpo/56-2/JALPO56-2-Spring2014.pdf

___________ (2015). "ALPO Observations of Saturn During the 2011-2012 Apparition," *Journal of the Assn. of Lunar & Planetary Observers*. Vol. 57, No. 2 (Spring), 2015, pp. 48-74. http://www.alpo-astronomy.org/djalpo/57-2/DJALPO57-2-Spring2015.pdf

___________ (2016). ALPO Observations of Saturn During the 2012-13 Apparition, JALPO, 58, 4: 53-80. (Available by request.)

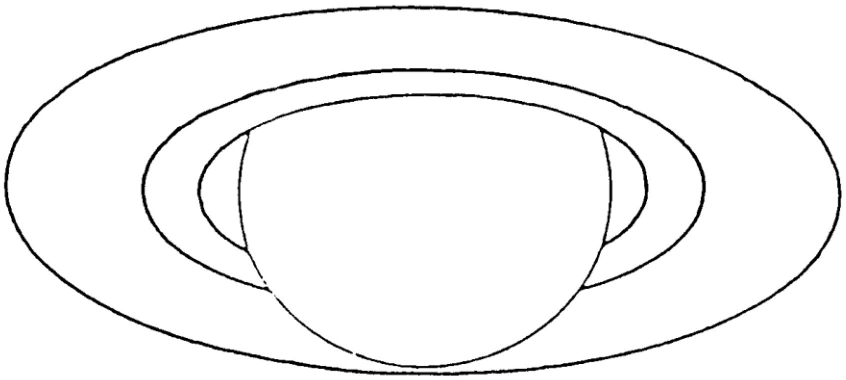
Lissauer, Jack J, and de Pater, Imke, *Fundamental Planetary Science*. New York: Cambridge University Press, 2013. http://www.amazon.com/dp/052161855X/?tag=mh0b-20&hvadid=4162391626&ref=pd_sl_7lqawqcmqg_e

United States Naval Observatory, *The Astronomical Almanac*. Washington: U.S. Government Printing Office. (Annual Publication; the 2013 and 2014 editions, which were published in 2012 and 2013, respectively, were used for this report). http://bookstore.gpo.gov/search/apachesolr_search/The%20Astronomical%20Almanac

Association of Lunar and Planetary Observers (A.L.P.O.): The Saturn Section

A.L.P.O. Visual Observation of Saturn for B = +26° to +28°

S



N

Coordinates (check one): [ ] IAU [ ] Sky

Observer__________________________________Location____

UT Date (start) ________________ UT Start ____________ CM I (start) __________° CM II (start) ____________° CM III (start) ____________°

UT Date (end) ______________ UT End ____________ CM I (end) ___________° CM II (end) ___________° CM III (end) ____________°

B = ________° B′ = _________° Instrument ____ Magnification(s) _________ x_{min} _________ x_{max}

Filter(s) IL(none) ____________ f_1 ____________ f_2 ____________ f_3 ____________ Seeing ______________ Transparency ________________

Saturn Global and Ring Features	**Visual Photometry and Colorimetry** IL	f_1	f_2	f_3	Absolute Color Estimates	**Latitude Estimates** ratio y/r

Bicolored Aspect of the Rings: (*always use IAU directions*)

No Filter (IL) (*check one*): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa
Blue Filter (________) (*check one*): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa
Red Filter (________) (*check one*): [ ] E ansa = W ansa [ ] E ansa > W ansa [ ] W ansa > E ansa

IMPORTANT: Attach to this form all descriptions of morphology of atmospheric detail, as well as other supporting information. Please do not write on the back of this sheet. The intensity scale employed is the *Standard A.L.P.O. Intensity Scale*, where 0.0 = completely black ⇔ 10.0 = very brightest features, and intermediate values are assigned along the scale to account for observed intensity of features.

ALPO Resources

People, publications, etc., to help our members

Board of Directors

http://www.alpo-astronomy.org/main/board.html

- Member of the Board (currently Associate Executive Director); Julius L. Benton, Jr., Associates in Astronomy, P.O. Box 30545, Wilmington Island, Savannah, GA 31410; *jlbaina@msn.com* (preferred) and *jbenton55@comcast.net*
- Member of the Board; Carl Hergenrother, 4101 North Sunnywood Place, Tuscon, AZ 85749; *chergen@lpl.arizona.edu*
- Member of the Board; Sanjay Limaye, University of Wisconsin, Space Science and Engineering Center, Atmospheric Oceanic and Space Science Bldg. 1017, 1225 W. Dayton St., Madison, WI 53706; *sanjayl@ssec.wisc.edu*
- Member of the Board; Ken Poshedly, 1741 Bruckner Ct., Snellville, GA 30078-2784; *ken.poshedly@alpo-astronomy.org*
- Member of the Board; Mike D. Reynolds, Dean of Liberal Arts & Sciences, Florida State College at Jacksonville, 3939 Roosevelt Blvd, F-112b, Jacksonville, FL 32205; *m.d.reynolds@fscj.edu*
- Member of the Board (currently Executive Director); Richard W. Schmude, Jr., Gordon State College, 419 College Dr., Barnesville, GA 30204; *schmude@gordonstate.edu*
- Member of the Board, Secretary/Treasurer; Matthew Will, P.O. Box 13456, Springfield, IL 62791-3456; *matt.will@alpo-astronomy.org*
- Founder/Director Emeritus; the late Walter H. Haas

Publications Section

- Coordinator (Editor & Publisher for *The Strolling Astronomer*; Ken Poshedly (all papers, submissions, etc, ALPO-Member-Discussion e-mail group moderator); 1741 Bruckner Ct, Snellville, GA 30078-2784; *ken.poshedly@alpo-astronomy.org*
- Book Review Editor; Robert A. Garfinkle, FRAS, 32924 Monrovia St., Union City, CA 94587-5433; *ragarf@earthlink.net*

Interest Sections

Computing Section

http://www.alpo-astronomy.org/computing

- Coordinator; Larry Owens, 4225 Park Brooke Trace, Alpharetta, GA 30022; *larry.owens@alpo-astronomy.org*
- Assistant Coordinator; Theo Ramakers, 130 Bluegrass Ct, Oxford, GA 30054; *theo@ceastronomy.org*

Lunar & Planetary Training Program

http://www.alpo-astronomy/training

- Coordinator; Timothy J. Robertson, 195 Tierra Rejada Rd., #148, Simi Valley, CA 93065; *cometman@cometman.net*

Online Section

http://www.alpo-astronomy.org/

- Coordinator (ALPO website); Larry Owens, 4225 Park Brooke Trace, Alpharetta, GA 30022; *larry@ceastronomy.org*
- Assistant Coordinator (ALPO social media); Steven Siedentop, 59 Mission Oak Dr., Grayson, GA 30017; *sdsiedentop@gmail.com*
- Assistant Coordinator; Theo Ramakers, 130 Bluegrass Ct, Oxford, GA 30054; *theo@ceastronomy.org*

Youth Section

http://www.cometman.net/youth

- Coordinator; Timothy J. Robertson,195 Tierra Rejada Rd., #148, Simi Valley, CA 93065; *cometman@cometman.net*

Observing Sections

Eclipse Section

http://www.alpo-astronomy.org/eclipseblog

- Coordinator; Mike D. Reynolds, Dean of Liberal Arts & Sciences, Florida State College at Jacksonville, 3939 Roosevelt Blvd, F-112b, Jacksonville, FL 32205; *m.d.reynolds@fscj.edu*
- Acting Assistant Coordinator; Keith Spring, 2173 John Hart Circle, Orange Park, FL 32073; *star.man13@hotmail.com*

Mercury/Venus Transit Section

http://www.alpo-astronomy.org/transit

- Coordinator; (open)
- Acting Assistant Coordinator; Keith Spring, 2173 John Hart Circle, Orange Park, FL 32073; *star.man13@hotmail.com*

Meteors Section

http://www.alpo-astronomy.org/meteor

- Coordinator; Robert D. Lunsford, 1828 Cobblecreek St., Chula Vista, CA 91913-3917; *lunro.imo.usa@cox.net*
- Assistant Coordinator; Robin Gray, P.O. Box 547, Winnemuca, NV 89446; *sevenvalleysent@yahoo.com*

Meteorites Section

http://www.alpo-astronomy.org/meteorite

- Coordinator; Dolores Hill, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721; *dhill@lpl.arizona.edu*

Comets Section

http://www.alpo-astronomy.org/comet

- Coordinator; Carl Hergenrother, 4101 North Sunnywood Place, Tuscon, AZ 85749; *chergen@lpl.arizona.edu*
- Assistant Coordinator; Gary Kronk, 153 Samarra Estates Dr, Fenton, MO 63026; *gkronk@gmail.com*

Solar Section

http://www.alpo-astronomy.org/solar

- Coordinator & Scientific Advisor; Richard Hill, 10130 E. King Manor Dr., Tucson, AZ 85730; *rhill@lpl.arizona.edu*
- Assistant Coordinator (new observers and ALPO Solar Section Online Image Archive contact); Theo Ramakers, 130 Bluegrass Ct, Oxford, GA 30054; *theo@ceastronomy.org*
- Assistant Coordinator (primary moderator, ALPO Solar Section Yahoo email list); Rick Gossett, 20251 Lakeworth St., Roseville, MI. 48066; *rick2d2@sbcglobal.net*
- Assistant Coordinator; Pam Shivak, P.O. Box 26288, Prescott Valley, AZ 86312; *pamelashivak@yahoo.com*

ALPO Resources

People, publications, etc., to help our members

Mercury Section

http://www.alpo-astronomy.org/Mercury

- Coordinator; Frank J. Melillo, 14 Glen-Hollow Dr., E-#16, Holtsville, NY 11742; frankj12@aol.com

Venus Section

http://www.alpo-astronomy.org/venus

- Coordinator; Julius L. Benton, Jr., Associates in Astronomy, P.O. Box 30545, Wilmington Island, Savannah, GA 31410; jlbaina@msn.com (preferred) and jbenton55@comcast.net

Lunar Section

- Coordinator; Wayne Bailey, 17 Autumn Lane, Sewell, NJ 08080; wayne.bailey@alpo-astronomy.org
- Assistant Coordinator; William Dembowski, 219 Old Bedford Pike, Windber, PA 15963; dembowski@zone-vx.com
- Assistant Coordinator; Jerry Hubbell, 406 Yorktown Blvd, Locust Grove, VA 22508; jerry.hubbell@comcast.net

Lunar Topographical Studies Program

http://moon.scopesandscapes.com/ALPO_Lunar_Program.htm

Lunar Selected Areas Program

http://moon.scopesandscapes.com/alpo-sap.html

Lunar Banded Craters Program

http://moon.scopesandscapes.com/alpo-bcp.htm

Lunar Domes Program

- Acting Coordinator; Raffaello Lena, Cartesio 144 D, 00137 Rome, Italy; raffaello.lena@alpo-astronomy.org
- Acting Assistant Coordinator; Jim Phillips, 101 Bull St., Charleston, SC 29401-1712; thefamily90@gmail.com

Lunar Meteoritic Impacts Search Program

http://www.alpo-astronomy.org/lunar/lunimpacts.htm

- Coordinator; Brian Cudnik, 11851 Leaf Oak Drive, Houston, TX 77065; cudnik@sbcglobal.net

Lunar Transient Phenomena

http://www.alpo-astronomy.org/lunar/LTP.html; also http://www.LTPresearch.org

- Coordinator; Dr. Anthony Charles Cook, Institute of Mathematical and Physical Sciences, University of Aberystwyth, Penglais, Aberystwyth, Ceredigion. SY23 3BZ, United Kingdom; tony.cook@alpo-astronomy.org
- Assistant Coordinator; David O. Darling, 416 West Wilson St., Sun Prairie, WI 53590-2114; DOD121252@aol.com

Mars Section

http://www.alpo-astronomy.org/Mars

- Coordinator; Roger J. Venable, MD, P.O. Box 117, Chester, GA 31012; rjvmd@hughes.net
- Assistant Coordinator (photometry and polarimetry); Richard W. Schmude, Jr., 109 Tyus St., Barnesville, GA 30204; schmude@gordonstate.edu
- Assistant Coordinator; Jim Melka, 14176 Trailtop Dr., Chesterfield, MO 63017; jtmelka@yahoo.com

Minor Planets Section

http://www.alpo-astronomy.org/minor

- Coordinator; Frederick Pilcher, 4438 Organ Mesa Loop, Las Cruces, NM 88011; fpilcher35@gmail.com
- Scientific Advisor: Alan W. Harris, 4750 Walnut St, Suite 205, Boulder, CO 80301; harrisaw@att.net
- Scientific Advisor; Dr. Petr Pravec, Ondrejov Observatory, Astronomical Institute, Academy of Sciences, Cz-25 165 Ondrejov, Czech Republic; ppravec@asu.cas.cz
- Asteroid Photometry Coordinator; Brian D. Warner, Center For Solar System Studies, 446 Sycamore Ave, Eaton, CO 80615; brian@MinorPlanetObserver.com

Jupiter Section

http://www.alpo-astronomy.org/jupiter

- Section Coordinator, Apparition Reports; Richard W. Schmude Jr., 109 Tyus St., Barnesville, GA 30204; schmude@gordonstate.edu
- Assistant Coordinator, Transit Timings; John McAnally, 2124 Wooded Acres, Waco, TX 76710; CPAJohnM@aol.com
- Assistant Coordinator, Newsletter; Craig MacDougal, 821 Settlers Road, Tampa, FL 33613; macdouc@verizon.net
- Galilean Satellite Eclipses program coordinator; Richard W. Schmude Jr., 109 Tyus St., Barnesville, GA 30204;

Saturn Section

http://www.alpo-astronomy.org/saturn

- Coordinator; Julius L. Benton, Jr., Associates in Astronomy, P.O. Box 30545, Wilmington Island, Savannah, GA 31410; ; jlbaina@msn.com (preferred) and jbenton55@comcast.net

Remote Planets Section

http://www.alpo-astronomy.org/remote

- Coordinator; Richard W. Schmude, Jr., 109 Tyus St., Barnesville, GA 30204; schmude@gordonstate.edu

****

ALPO Publications

The Monograph Series

http://www.alpo-astronomy.org/publications/Monographs page.html

Publications too lengthy for publication in *The Strolling Astronome*r. All are available online as a pdf files. NONE are available any longer in hard copy format. There is NO CHARGE for any of the ALPO monographs.

- **Monograph No. 1.** *Proceedings of the 43rd Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, August 4-7, 1993. 77* pages. File size approx. 5.2 mb.

- **Monograph No. 2**. *Proceedings of the 44th Convention of the Association of Lunar and Planetary Observers. Greenville, South Carolina, June 15-18, 1994. 52* pages. File size approx. 6.0 mb.

- **Monograph No. 3**. *H.P. Wilkins 300-inch Moon Map.* 3rd Edition (1951). Available as one comprehensive file (approx. 48 megabytes) or five section files (Part 1, 11.6 megabytes; Part 2, 11.7 megabytes; Part 3, 10.2 megabytes; Part 4, 7.8 megabytes; Part 5, 6.5 mb)

ALPO Resources

People, publications, etc., to help our members

- **Monograph No. 4.** *Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.127* pages. Hard copy $17 for the United States, Canada, and Mexico; $26 elsewhere. File size approx. 2.6 mb.

- **Monograph No. *5.*** *Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir; 1877-1878.* By Giovanni Virginio Schiaparelli, translated by William Sheehan. 59 pages. Hard copy $10 for the United States, Canada, and Mexico; $15 elsewhere. File size approx. 2.6 mb.

- **Monograph No. *6.*** *Proceedings of the 47th Convention of the Association of Lunar and Planetary Observers, Tucson, Arizona, October 19-21, 1996.20* pages. Hard copy $3 for the United States, Canada, and Mexico; $4 elsewhere.File size approx. 2.6 mb.

- **Monograph No. 7.** *Proceedings of the 48th Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, June 25-29, 1997.76* pages. Hard copy $12 for the United States, Canada, and Mexico; $16 elsewhere.File size approx. 2.6 mb.

- **Monograph No. 8**. *Proceedings of the 49th Convention of the Association of Lunar and Planetary Observers. Atlanta, Georgia, July 9-11,1998.122* pages. Hard copy $17 for the United States, Canada, and Mexico; $26 elsewhere.File size approx. 2.6 mb.

- **Monograph Number 9**. *Does Anything Ever Happen on the Moon?* By Walter H. Haas. Reprint of 1942 article. 54 pages.Hard copy $6 for the United States, Canada, and Mexico; $8 elsewhere.File size approx. 2.6 mb.

- **Monograph Number 10.** *Observing and Understanding Uranus, Neptune and Pluto*. By Richard W. Schmude, Jr. 31 pages. File size approx. 2.6 mb.

- **Monograph No. 11**. *The Charte des Gebirge des Mondes* (Chart of the Mountains of the Moon) by J. F. Julius Schmidt, this monograph edited by John Westfall. Nine files including an accompanying guidebook in German.

  Note files sizes:
  Schmidt0001.pdf, approx. 20.1 mb;
  Schmidt0204.pdf, approx. 32.6 mb;
  Schmidt0507.pdf, approx. 32.1 mb;
  Schmidt0810.pdf, approx. 31.1 mb;
  Schmidt1113.pdf, approx. 22.7 mb;
  Schmidt1416.pdf, approx. 28.2 mb;
  Schmidt1719.pdf, approx. 22.2 mb;
  Schmidt2022.pdf, approx. 21.1 mb;
  Schmidt2325.pdf, approx. 22.9 mb;
  SchmidtGuide.pdf,approx. 10.2 mb

ALPO Observing Section Publications

Order the following directly from the appropriate ALPO section recorders; use the address in the listings pages which appeared earlier in this booklet unless another address is given.

- **Solar:** *Guidelines for the Observation of White Light Solar Phenomena*, *Guidelines for the Observing Monochromatic Solar Phenomena* plus various drawing and report forms available for free as pdf file downloads at http://www.alpo-astronomy.org solarblog.

- **Lunar & Planetary Training Section:** *The Novice Observers Handbook* $15. An introductory text to the training program. Includes directions for recording lunar and planetary observations, useful exercises for determining observational parameters, and observing forms. Available as pdf file via e-mail or send check or money order payable to Timothy J. Robertson, 195 Tierra Rejada Rd., #148, Simi Valley, CA 93065; e-mail cometman@cometman.net.

- **Lunar:** (1) *The ALPO Lunar Selected Areas Program Handbook* (hardcopy, $17.50). Includes full set of observing forms. (2) *Observing forms*: Send a SASE for a hardcopy of forms. Both the Handbook and individual observing forms are available for download (as pdf files) at moon.scopesandscapes.com/alpo-sap.html. Use of observing forms will ensure that all requested information is included with observations, but are not required. Various lists and forms related to other Lunar section programs are also available at moon.scopesandscapes.com. NOTE: Observers who wish to make copies of the observing forms may instead send a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the ALPO lunar SAP section. Observers should make copies using high-quality paper.

- **Lunar**: *The Lunar Observer*, official newsletter of the ALPO Lunar Section, published monthly. Free at http://moon.scopesandscapes.com/tlo.pdf or send SASE to: Wayne Bailey, 17 Autumn Lane, Sewell, NJ 08080.

- **Venus (Benton):** Introductory information for observing Venus, the comprehensive *ALPO Venus Handbook*, as well as all observing forms and ephemerides, can be conveniently downloaded as pdf files at no cost to ALPO members and individuals interested in observing Venus as part of our regular programs at http://www.alpo-astronomy.org/venus.

- **Mars:** Free resources are on the ALPO website at www.alpo-astronomy.org . Click on "Mars Section" in the left column; then on the resulting webpage, look for links to resources in the right column including “Mars Observing Form”, and "Mars Links". Under “Mars Links”, click on "Mars Observers Cafe", and follow those links to The New “Internet Mars Observer's Handbook.”

- **Minor Planets (Derald D. Nye):** *The Minor Planet Bulletin*. Published quarterly; free at http://www.minorplanetobserver.com/mpb/default.htm. Paper copies available only to libraries and special institutions at $24 per year via regular mail in the U.S., Mexico and Canada, and $34 per year elsewhere (airmail only). Send check or money order payable to “Minor Planet Bulletin”, c/o Derald D. Nye, 10385 East Observatory Dr., Corona de Tucson, AZ 8564l-2309.

- **Jupiter:** *(1) Jupiter Observer’s Handbook*, from the Astronomical League Sales, temporarily out of stock. (2) *Jupiter*, the ALPO section newsletter, available from Craig MacDougal at *macdouc@verizon.net;* (3) *ALPO_Jupiter*, the ALPO Jupiter Section e-mail network; to join, send a blank e-mail to *ALPO_Jupiter-*

ALPO Resources

People, publications, etc., to help our members

subscribe@yahoogroups.com (4) *Timing the Eclipses of Jupiter's Galilean Satellites* free at *http://www.alpo-astronomy.org/jupiter/GaliInstr.pdf*, report form online at *http://www.alpo-astronomy.org/jupiter/GaliForm.pdf*; send SASE to John Westfall for observing kit and report form via regular mail. (5) *Jupiter Observer's Startup Kit*, $3 from Richard Schmude, Jupiter Section Coordinator.

- **Saturn (Benton):** Introductory information for observing Saturn, including all observing forms and ephemerides, can be conveniently downloaded as pdf files at no cost to ALPO members and individuals interested in observing Saturn as part of our regular programs at *http://www.alpo-astronomy.org/saturn*. The former *ALPO Saturn Handbook* was replaced in 2006 by *Saturn and How to Observe It* (authored by Julius L. Benton) and it can be obtained from book sellers such as *Amazon.com*.
- **Meteors:** (1) *The ALPO Guide to Watching Meteors* (pamphlet). $3 per copy (includes postage & handling); send check or money order to Astronomical League Sales, 9201 Ward Parkway, Suite 100, Kansas City, MO 64114; phone 816-DEEP-SKY (816-333-7759); e-mail *leaguesales@astroleague.org*. (2) *The ALPO Meteors Section Newsletter*, free (except postage), published quarterly (March, June, September and December). Send stamps, check or money order for first class postage to cover desired number of issues to Robert D. Lunsford, 1828 Cobblecreek St., Chula Vista, CA 91913-3917.

Back Issues of *The Strolling Astronomer*

Download JALPO43-1 thru the latest available issue as a pdf file from the ALPO Publications Section Gallery via the ALPO website at *http://www.alpo-astronomy.org* Note that the newest four issues are available for downloading only by ALPO members.

Some hard-copy back issues listed below may be out of stock with no guarantee of availability. Issues are sold on a first-come, first-served basis. Back issues are $4 each, and $5 for the current issue. Discounts available on orders over $30. Contact Secretary/Treasurer Matthew Will for downloading instructions or to ordr hard copies (see address under "Board of Directors,"):

$4 each:
Vol. 16 (1962) Nos. 3-4
Vol. 17 (1963) Nos. 1-2
Vol. 19 (1965) Nos. 3-4
Vol. 29 (1981-83) Nos. 1-2 and 11-12
Vol. 30 (1983-84) Nos. 1-2, 7-8, 9-10
Vol. 32 (1987-88) Nos. 3-4, 10-12
Vol. 33 (1989) Nos. 10-12
Vol. 34 (1990) Nos. 1 and 3
Vol. 35 (1991) Nos. 1, 2, and 4
Vol. 36 (1992-93) Nos. 1, 2, 3, and 4
Vol. 37 (1993-94) Nos. 1, 2, 3, and 4
Vol. 38 (1994-96) Nos. 1, 2, 3, and 4
Vol. 39 (1996-97) Nos. 1, 2, 3, and 4
Vol. 40 (1998) Nos. 2 and 3
Vol. 41 (1999) Nos. 1, 2, and 3
Vol. 42 (2000) Nos. 1 and 4
Vol. 43 (2001) Nos. 1, 2, 3, and 4
Vol. 44 (2002) Nos. 1, 2, 3, and 4
Vol. 45 (2003) Nos. 1, 2, and 3 (no issue 4)
Vol. 46 (2004) Nos. 1, 2, 3, and 4
Vol. 47 (2005) Nos. 1, 2, 3, and 4
Vol. 48 (2006) Nos. 1, 2, 3, and 4
Vol. 49 (2007) Nos. 1, 2, 3, and 4
Vol. 50 (2008) Nos. 1, 2, 3, and 4
Vol. 51 (2009) Nos. 1, 2, 3, and 4
Vol. 52 (2010) Nos. 1, 2, 3, and 4
Vol. 53 (2011) Nos. 1, 2, 3, and 4
Vol. 54 (2012) Nos. 1, 2, 3, and 4
Vol. 55 (2013) Nos. 1, 2, 3 and 4
Vol. 56 (2014) Nos. 1, 2, 3 and 4
Vol. 57 (2015) Nos. 1, 2, 3 and 4
Vol. 58 (2016) Nos. 1, 2, 3 and 4
Vol. 59 (2017) Nos. 1, 2, 3 and 4
Vol. 60 (2018) Nos. 1, 2 and 3

$5: Vol. 60 (2018) No. 4 (current issue)

THE ASSOCIATION OF LUNAR & PLANETARY OBSERVERS (ALPO)

The Association of Lunar & Planetary Observers (ALPO) was founded by Walter H. Haas in 1947 and incorporated in 1990 as a medium for advancing and conducting astronomical work by both professional and amateur astronomers who share an interest in Solar System observations. We welcome and provide services for all individuals interested in lunar and planetary astronomy. For the novice observer, the ALPO is a place to learn and to enhance observational techniques. For the advanced amateur astronomer, it is a place where one's work will count and be used for future research purposes. For the professional astronomer, it is a resource where group studies or systematic observing patrols add to the advancement of astronomy.

Our Association is an international group of students that study the Sun, Moon, planets, asteroids, meteors, meteorites and comets. Our goals are to stimulate, coordinate, and generally promote the study of these bodies using methods and instruments that are available within the communities of both amateur and professional astronomers. We hold a conference each summer, usually in conjunction with other astronomical groups.

We have "sections" for the observation of all the types of bodies found in our Solar System. Section coordinators collect and study submitted observations, correspond with observers, encourage beginners, and contribute reports to our quarterly Journal at appropriate intervals. Each section coordinator can supply observing forms and other instructional material to assist in your telescopic work. You are encouraged to correspond with the coordinators in whose projects you are interested. Coordinators can be contacted either via e-mail (available on our website) or at their postal mail addresses listed in our Journal. Members and all interested persons are encouraged to visit our website at *http://www.alpo-astronomy.org*. Our activities are on a volunteer basis, and each member can do as much or as little as he or she wishes. Of course, the ALPO gains in stature and in importance in proportion to how much and also how well each member contributes through his or her participation.

Our work is coordinated by means of our quarterly periodical, the *Journal of the Assn. of Lunar & Planetary Observers*, also called *The Strolling Astronomer*. Membership dues include a subscription to our Journal. Two versions of our Journal are distributed — a hardcopy (paper) version and an online (digital) version in "portable document format" (pdf) at considerably reduced cost.

Subscription rates and terms are listed below (effective March 1, 2015).

We heartily invite you to join the ALPO and look forward to hearing from you.

- ..$US14 – 4 issues of the digital Journal only, all countries, e-mail address required
- ..$US24 – 8 issues of the digital Journal only, all countries, e-mail address required
- ..$US39 – 4 issues of the paper Journal only, US, Mexico and Canada
- ..$US72 – 8 issues of the paper Journal only, US, Mexico and Canada
- ..$US46 – 4 issues of the paper Journal only, all other countries
- ..$US86 – 8 issues of the paper Journal only, all other countries
- ..$US75 – Sustaining Member level, 4 issues of the digital and paper Journal, all countries
- ..$US150 – Sponsoring Member level, 4 issues of the digital and paper Journal, all countries

For your convenience, you may join online via the via the Internet or by completing the form at the bottom of this page.

To join or renew online, simply left-click on this Astronomical League web page:
http://www.astroleague.org/store/index.php?main_page=product_info&cPath=10&products_id=39

Afterwards, e-mail the ALPO membership secretary at *matt.will@alpo-astronomy.org* with your name, address, the type of membership and amount paid.

If using the form below, please make payment by check or money order, payable (through a U.S. bank and encoded with U.S. standard banking numbers) to "ALPO" There is a 20-percent surcharge on all memberships obtained through subscription agencies or which require an invoice. Send to: ALPO Membership Secretary, P.O. Box 13456, Springfield, Illinois 62791-3456 USA.

Please Print:
Name____
Street Address______________________________________
____
City, State, ZIP _____________________________________
E-mail Address______________________________________
Phone Number_______________________________________
Please share your observing interests with the ALPO by entering the appropriate codes on the blank line below.
Interest____

Interest Abbreviations
0 = Sun 1 = Mercury 2 = Venus 3 = Moon 4 = Mars 5 = Jupiter 6 = Saturn 7 = Uranus 8 = Neptune 9 = Pluto A = Asteroids C = Comets D = CCD Imaging E = Eclipses & Transits H = History I = Instruments M = Meteors & Meteorites P = Photography R = Radio Astronomy S = Computing & Astronomical Software T = Tutoring & Training Program (including Youth)